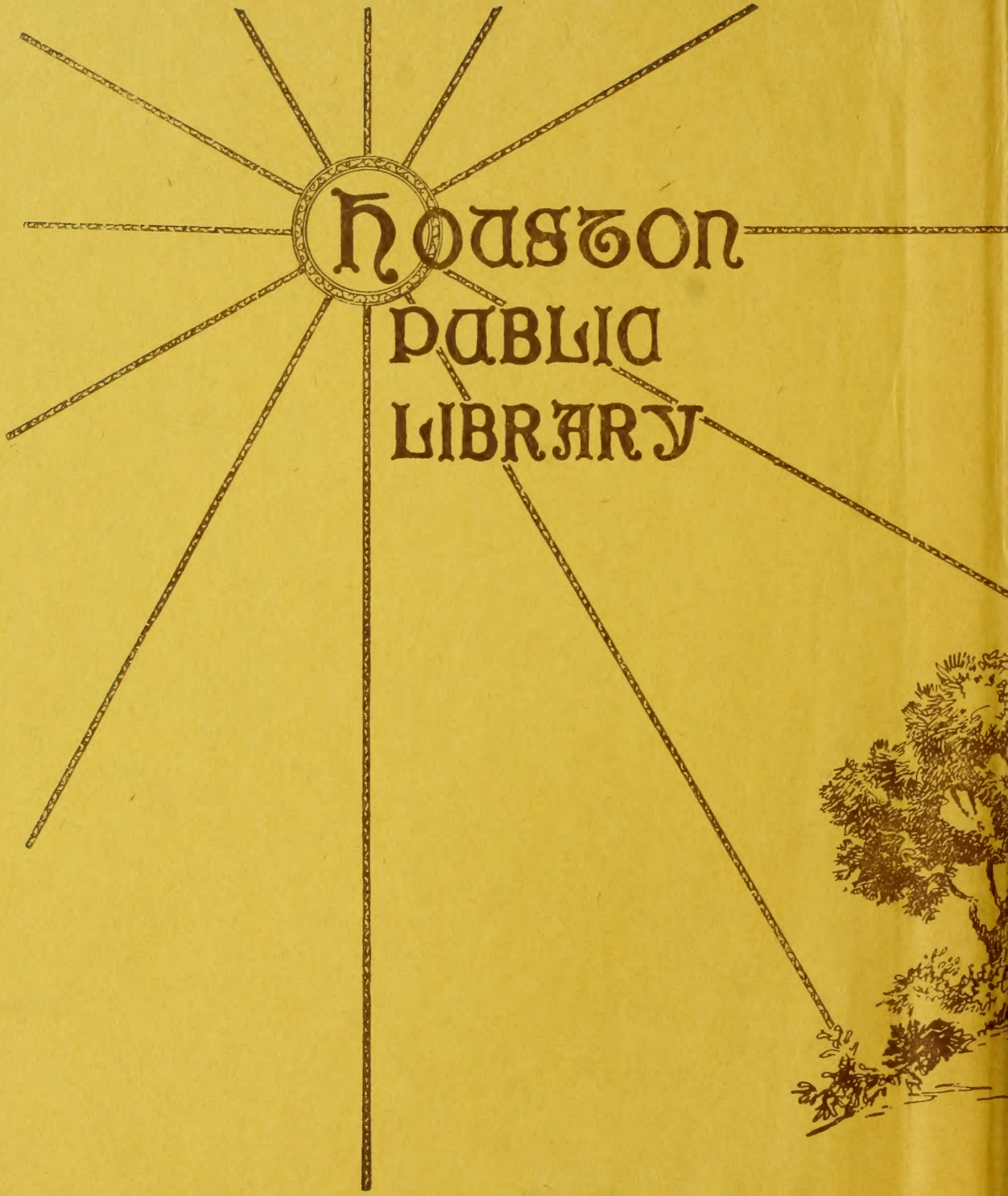

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MAY 6, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

MAY 1963
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First U.S. Cover Photo Via ComSat

- More Re-entry Work Goes West
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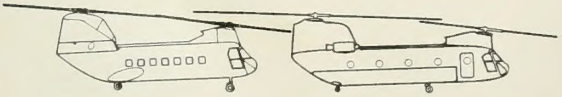

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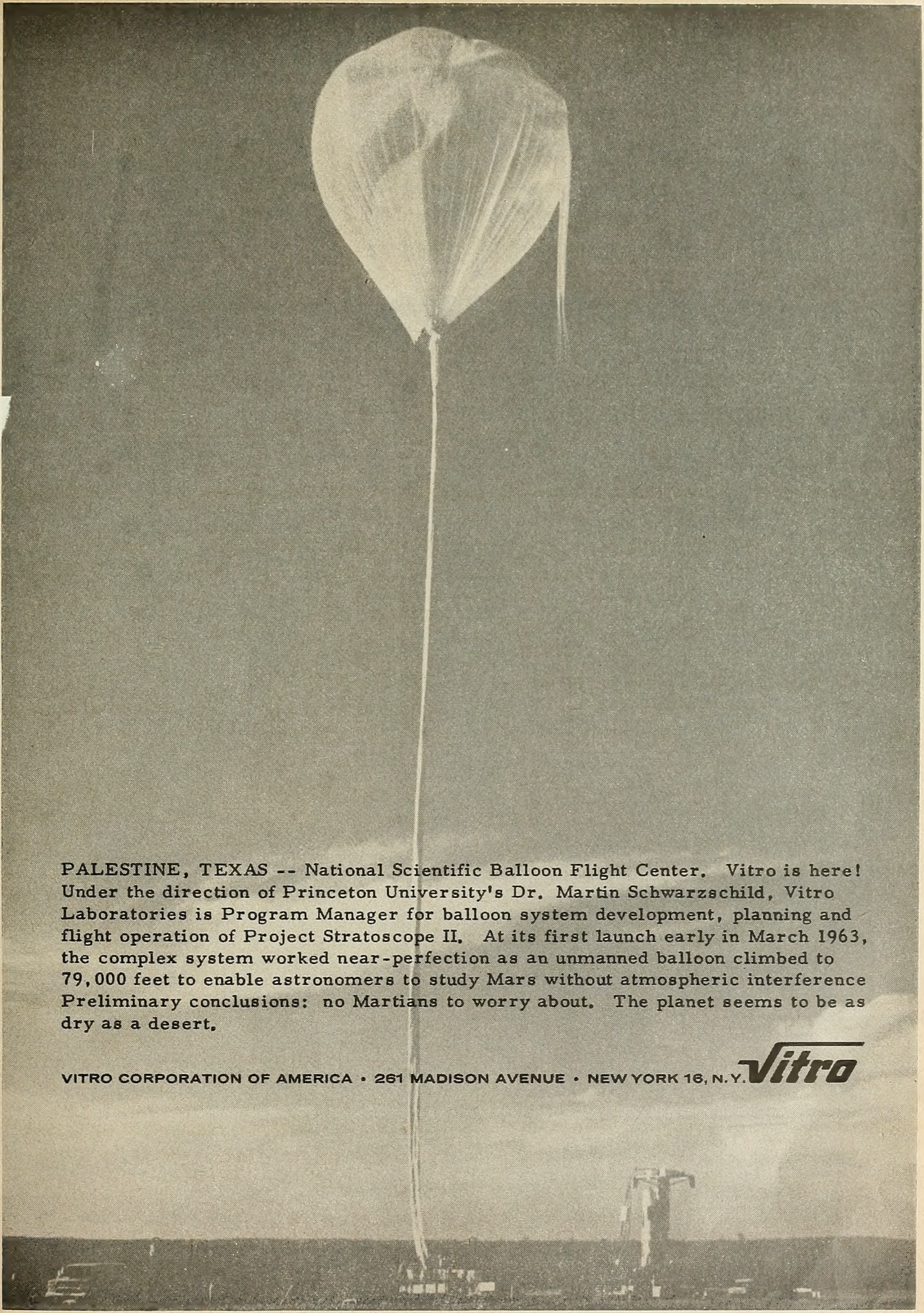

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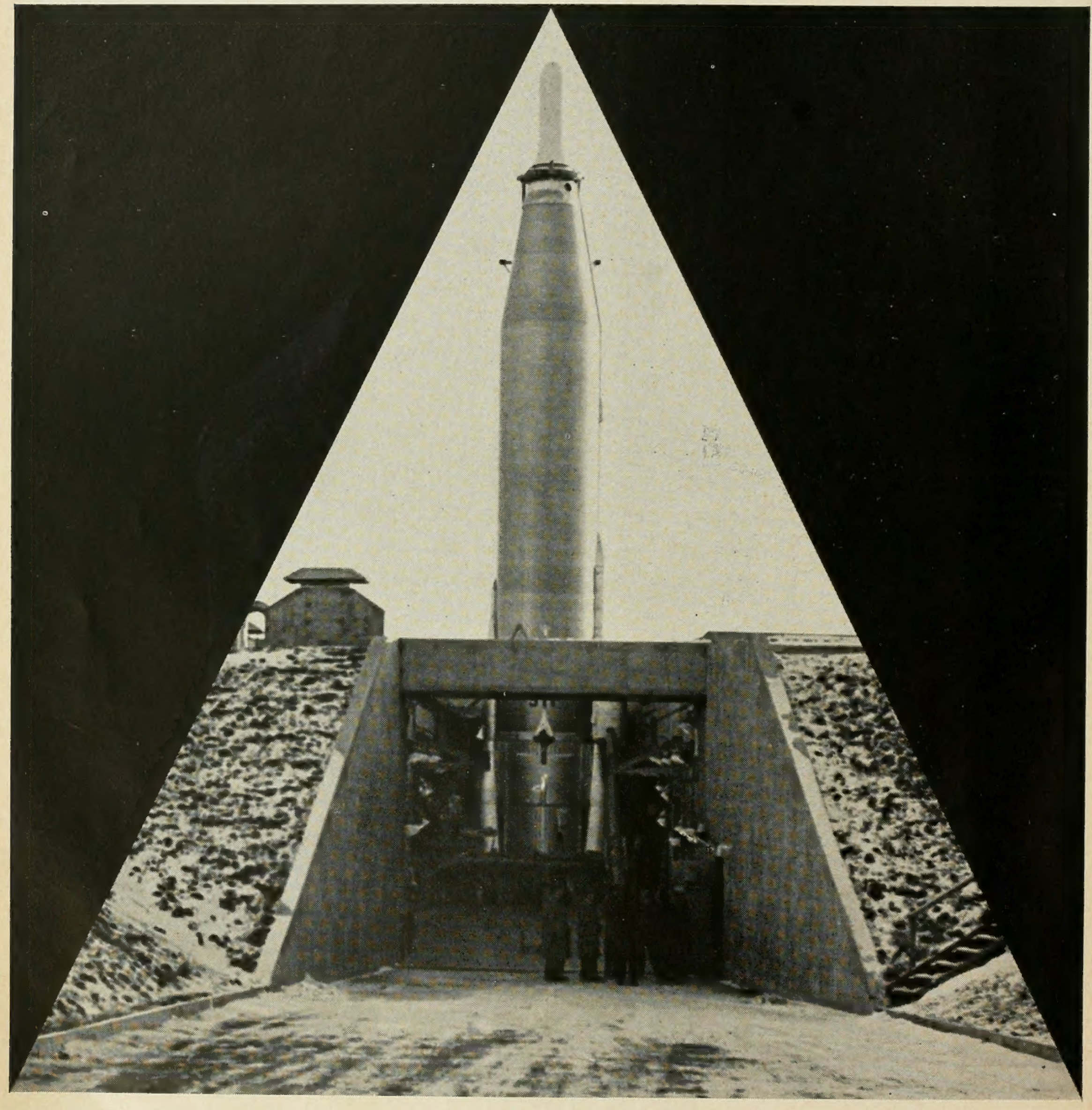

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets Volume 12, Number 18 May 6, 1963

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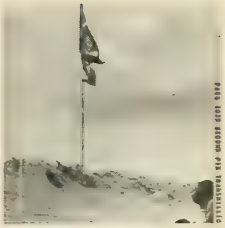
THE COVER

Photo of British soldier with Vigilant antitank missile in Norway is one of two pictures sent from Britain to Missiles and Rockets *via NASA's Relay communications satellite. It's the first U.S. magazine cover transmitted by a ComSat. See p. 26.*



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letters

Making Do

To the Editor:

Reading the item, "Edible Space Station Material Developed" (M/R, April 15, p. 35), brought on this verse (?):

Old Mother Hubbard went to the cupboard
To get her poor dog a bone.
But when she got there,
The cupboard was bare.
But this doesn't bother
The Space Age mother,
For the shelves will serve for a while.
So add to the rhyme
That at this time
We'll eat till the walls are bare.
(With apologies to Charles Perrault.)

Helmuth I. Stone
Rantoul, Ill.

Cislunar Space Data

To the Editor:

Will you be so kind as to inform me as to whether the temperature vs. altitude data shown graphically in "Properties of Cislunar Space" on the center page of M/R, Jan. 21 (pp. 26 & 27) are based on actual instrumental readings or recordings—and, if so, what means were used to obtain such readings?

Grandison Gardner
Maj. Gen. U.S. Air Force (Ret.)
Phoenix, Ariz.

Temperatures were the averages of actual readings taken from ion temperature and density gages and electron temperature gages mounted in rockets and satellites.—Ed.

Enthusiasm at Cape

To the Editor:

In your March 11 issue, you announced that NASA will build three new tracking stations in Australia.

This is written to request more details or specifics, if possible. Are there any new developments? Have the contracts been let? Who were the successful or presently interested bidders? Or—how does NASA intend to handle the contract, and when?

I'm not certain of the proper nomenclature *S-6* or *S-4*, but tonight we stood on the beach and watched the *Thor* lift off and head into orbit with the latest space probe. Ignition and lift-off were spectacular—nothing less. The night was clear, launch pad lights on, and the rocket ignition smoke was a beautiful, still, solitary ground-hovering cloud. It looked like a beautiful flight—the reportedly intentional, strange, low-seeming arch on a northeast trajectory caused a murmur of concern among spectators. However, all were 100% supporters for success. That's what has impressed us here—everyone cheers them all—*Titan II, Pershing, Thor, Polaris, Atlas, Minuteman,* or *Saturn.* It makes no difference as to personal affiliation, we at Cape Canaveral fly successful Free World Missiles!

Please note: We also cheer your free-thinking, free-spoken editorials!

J. Dave Moffatt
Cocoa Beach, Fla.

Reader Moffatt's enthusiasm on all counts is appreciated. When more information is available regarding the new Australian sites, he will receive it.—Ed.

New Product Award

To the Editor:

I was very pleased to see that M/R is awarding a "New Product of the Year" prize. It is too often that the press lavishes its editorial attention on the "sexy" systems which have all the glamor. People too often forget that it is largely a collection of "new products" which make up any new system of any kind.

I often talk to people who are so busy looking at the big picture of this business that they forget there is such a thing as sitting up until the wee hours at a drawing board trying to squeeze an extra percentage point of performance out of the most lowly component.

With all the so-called top-grade talent going into the big companies with the most alluring advertising, it seems hard to believe that some little outfit can still come up with a good enough idea to win a national award. And it's the little nuts-and-bolts parts in these birds that have to make the grade, or else the whole thing is a waste of time.

To paraphrase Fleet Admiral Ernest J. King:

"A missile saved is worth two built. Think it over."

George M. Bauer
Philadelphia

Astrolog Reprints

Reprints of Missiles and Rockets' *latest Astrolog, the status report on missiles and space programs appearing on pp. 31-37 of this issue, may be ordered from:*

Research Department
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The reprint price is 35 cents per copy. Payment must accompany the order.

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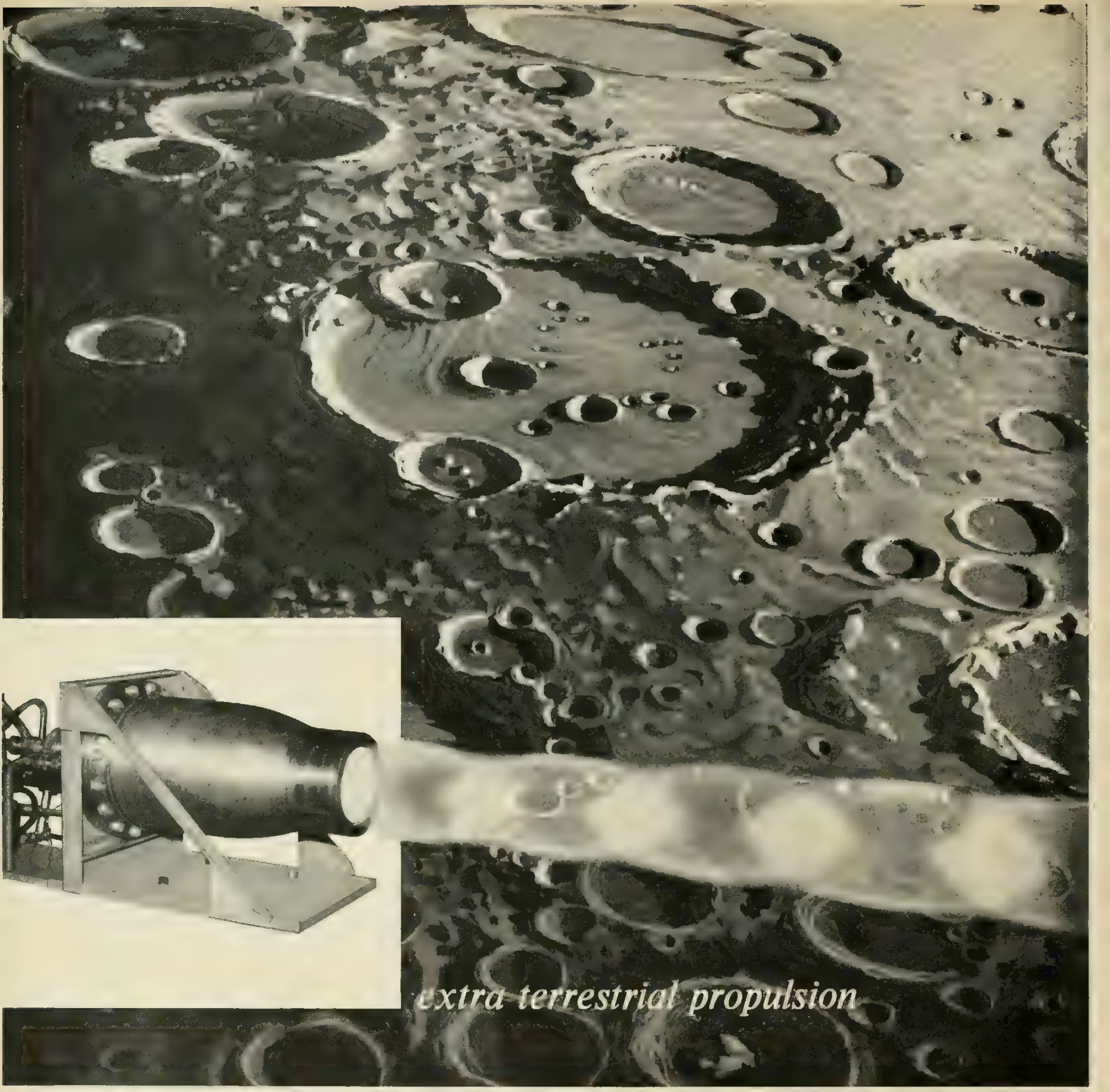

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Many space missions require rocket engines whose thrust level can be accurately controlled over a wide range. STL scientists and engineers are developing a family of such engines, including the 5000 pound bipropellant rocket engine shown above. These engines can vary their thrust across a throttle range greater than 40 to 1 while maintaining high combustion efficiency and limiting propellant residuals. With each test firing of the 5000 pound engine (and its 500 pound counterpart), the insight of STL scientists and engineers grows keener in areas of extra terrestrial propulsion. New positions have been created by this project, by STL's work as prime contractor for NASA's OGO, by its prime contractor assignment on a new series of Air Force-ARPA spacecraft, by its Systems Management activities for the Air Force's Atlas, Titan and Minuteman programs, and by other space responsibilities. Openings are in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern Calif., or Cape Canaveral positions, write Dr. R. C. Potter, Dept. B-5, One Space Park, Redondo Beach, Calif., or P. O. Box 4277, Patrick AFB, Fla. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Air Force Funds Orion Program

Project *Orion*, the proposal for boosting large space vehicles by nuclear explosions, is being financially supported in FY 1964 by reprogramming of present Air Force funds. AF asked for R&D funding of $9.8 million for the pulsed nuclear engine in FY '64, but was turned down by Dept. of Defense.

Navy Improves SAM Capability

Navy plans design improvements of its *Tartar, Terrier* and *Talos* surface-to-air weapons totaling $120.8 million, but has deferred spending of $190 million for a new *Typhon* SAM frigate until slippage is made up in that program.

NASA Holds Up SNAP-8 Funding

NASA has decided not to fund hardware development of the SNAP-8 project until further progress is made in its design. The space agency, however, will go ahead with the MECA project. This employs a small two-stage solid rocket to launch a 950-lb. experiment in a ballistic trajectory. The flight will test the mercury fluid and boiler and condenser component configurations of SNAP-8.

Skybolt Is Booster for Titan

Some of the money saved by cancellation of the *Skybolt* ALBM is being reprogrammed by the Air Force to meet mounting site activation costs of *Titan II*. Schedule for site activation is continuing to slip.

M-1 Comes Under Congressional Fire

Aerojet-General's M-1 engine program is in trouble with Congress. The House Space Committee has questioned the need for M-1 in view of the delayed planning for *Nova*. Also under scrutiny: the jump in program cost from $90 million to well above $230 million.

Name Change Planned for Gemini Board

The Joint NASA-Dept. of Defense *Gemini* Program Planning Board is in for a name change. In the future, it will be known as the Space Program Planning Board. This reflects a broadening of its responsibilities to include such programs as the *Manned Orbital Development Station* (*MODS*).

Sea Mauler to Get ASW Mission

Navy has testified before Congress that it is planning to use *Sea Mauler*, the ocean-going version of Convair/Pomona's *Mauler*, in an antisubmarine capacity. Navy sources say the weapon, to be mounted on small ships, also can be used in mine warfare.

DOD to Restudy Tactical Missile Requirements

Dept. of Defense has initiated a new comprehensive study of the number of tactical missiles required for the inventory. This involves a revision of estimating methods.

LEM Expected to Fill Cargo Role

Project *Apollo* officials now believe the best configuration for the contemplated lunar logistics system is the cargo version of LEM. The so-called CLEM (Cargo Lunar Excursion Module) vehicle would carry supplies to the lunar surface in place of the ascent stage and the two-man crew. Program still has not been approved by top NASA management—but a decision is expected by mid-year.

INDUSTRY

Saturn SA-5 to Carry LSI TV Camera

A television camera will be carried aboard the *SA-5 Saturn* flight this fall to monitor the separation of the first and second stages. Details of the camera have not yet been released, but it is expected to be similar to the miniaturized one Astronaut Gordon Cooper will carry on the *MA-9 Mercury* flight. The cameras are built by Lear Siegler in both slow and normal-scan versions.

Titan III Transtage Chamber Is Tested

Aerojet-General has just disclosed successful completion of a test firing of the thrust chamber for the *Titan III* Transtage engine. The March firing was 45 days ahead of schedule. Aerojet reports that the uncooled ablative chamber design was proven in two consecutive firings totaling almost nine minutes. Temperatures reached 5,000°F. The pumpless engine employs hypergolic propellants forced into the thrust chamber by gas pressure. The two-chamber engine will develop about 16,000 lbs. of thrust.

POGO S-50 to Use UV Spectrometer

NASA has decided to include an extreme ultraviolet scanning spectrometer in its *POGO S-50* polar-orbiting geophysical satellite slated for launch next year. The spectrometer will be built by Dr. Hans H. Hinteregger of Air Force's Cambridge Research Laboratory.

AF Negotiating $280 Million Titan III Award

Air Force is negotiating a $280-million *Titan III* contract with the Martin Co. This figure includes the $50-million award already announced.

Army to Award Three AADS-70 Contracts

Award of three feasibility study contracts for *AADS-70*, the new Army concept for a 1970 air defense system, is expected next week. *AADS-70* is a successor to the earlier *FABMDS* (Field Army Ballistic Missile Defense System).

INTERNATIONAL

India Plans to Build Russian Rockets

India's Minister of Defense Production says the agreement with the Soviet Union on production of Mig aircraft in India also covers armament. This is taken as an indication that Soviet air-to-air missiles will be made or at least assembled there.

A Busy Flight in Australia

A *Skylark* rocket launched to a 145-mile apogee at Woomera, Australia, for the British Meteorological Office ejected grenades, sodium vapor, chalk powder and a balloon at various levels during its ascent. The test was described as successful.

Shea Underscores Reliability

The "test-retest-and-test-again" philosophy used at Cape Canaveral to produce the recent string of successful *Saturn I* launches must be adopted by contractors to make the Cape operation the redundant check it was intended to be according to Joseph F. Shea, deputy director for systems of the NASA Office of Manned Space Flight.

Shea, during a speech at the second annual manned space flight conference in Dallas, called reliability predictions for manned space flight "discouraging," if based on total U.S. experience in space. In crediting the Cape operation with recent successes, he rebuked industry for often giving lip service to testing standards in their proposals while actually concentrating only on getting the product past the inspectors and out the door.

The deputy director attempted to quiet the growing controversy over the systems engineering role of Bellcomm, Inc., in the manned space flight program by pointing out that the contractor will not have the technical direction assignment that made Ramo-Wooldrige Corp. and Space Technology Laboratories unpopular with ballistic missile contractors.

Shea admitted that the working relationships of ballistic missile systems engineering contractors has been "difficult" because they were required to supervise essentially competitive corporations in actual development and engineering work.

In the NASA organization, the NASA centers are interposed between Bellcom and the contractors to supervise the implementation of the program with an eye toward eliminating the objections of industry.

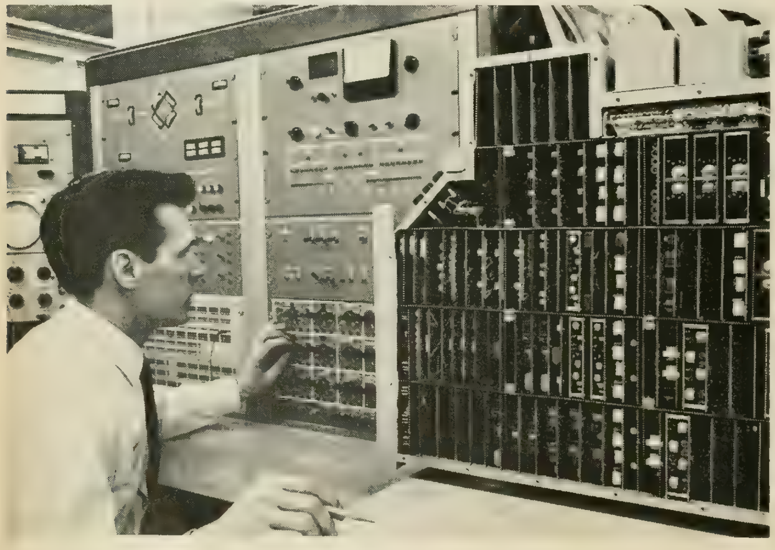
Shea acknowledged that technical impartiality will be necessary if Bellcomm is to be effective and that technical impartiality is difficult to achieve.

He said NASA had tried to recruit its own systems engineering organization but had been prevented by the restrictions in the civil service structure.

Second Centaur Pad Begun

Construction of a second launch complex for *Centaur* has begun at Cape Canaveral, thus providing a dual launch capability for the NASA vehicle.

Now planned for completion in late 1964, the double pad will allow one launch per month. The new complex, known as 36B, will share a common blockhouse with the other *Centaur* complex, 36A.



Checking Out Dyna-Soar Computer

EVALUATION ENGINEER at Honeywell's aeronautical division, Minneapolis, gives pre-shipment checkout to computer for Air Force's X-20 Dyna-Soar automatic flight control subsystem, using special equipment developed solely for this purpose. Computer will next be sent to Seattle, where Boeing Co., Dyna-Soar spacecraft and systems integrator, will test self-adaptive circuitry with X-20 simulator.

Incentive Contracts Stressed

Cost-plus-fixed-fee contracts should be replaced to an increasing extent with contracts offering financial incentives based not only on cost factors but also on schedule and quality targets, Walter L. Lingle, Jr., said last week at a meeting of the National Capital Section of the American Institute of Aeronautics and Astronautics.

Emphasizing that the space agency would like to eliminate the CPFF-type contract if at all possible, NASA's Deputy Associate Administrator for Industry Affairs said that sensibly set schedule and quality targets could effectively reduce costs as well as bring a project to timely completion.

DOD Space View Outlined

A capsule treatment of DOD's philosophy regarding space has been presented to the Senate space committee by Deputy Defense Secretary Roswell Gilpatric. Largely a justification for not embarking on a purely military space effort, the statement contained some insight into DOD thinking:

"The United States has a single national space program. . . . Space, like other mediums, affords useful and often unique ways for achieving defense objectives. Some of these are by no means uniquely military . . . similar remarks would apply to machines and devices used in the air, on land and on sea, and space is no exception. . . . As a corollary to these observations, the totality of our military space efforts, assessed from a national rather than a departmental standpoint, greatly exceeds the efforts of the Department of Defense alone. Space systems and devices are not simply military or non-military merely because they are developed by one agency or another."

While thus appearing to rule out any future objective of DOD to set up a coherent national military space effort, Gilpatric nevertheless described the other side of the coin:

"While acknowledging that space is not inevitably or predicatably the key to future military power, we must remain alert to the possibility that it could grow in importance as technology evolves. Thus, while about half of our current Defense space effort is associated with today's identifiable mission requirements, the other half is invested in a program of technological insurance against an uncertain future.

"Finally, it is important to understand that, within the Defense Department a 'military space program' does not exist as a separate entity. Space or space-related projects are integrated, on a functional basis, throughout our program structure. . . . Space efforts which are very costly, and which may not contribute heavily or directly to high priority near-term objectives, always compete with other projects that do.

"Secertary McNamara specified two fundamental criteria that Defense Department space activities must meet. . . . Such space projects must promise to enhance our military power and effectiveness . . . and our Defense space program must mesh with the efforts of NASA in all vital areas."

Gilpatric cited the numerous DOD/NASA agreements on space as an indication of DOD interest in the field. However, he qualified the DOD interest with the now-established argument that a requirement must be evident.

"Manned space flight efforts are expensive—even when undertaken as limited exploratory efforts. They would be much more expensive if they were undertaken unilaterally by either DOD or NASA for routine, repetitive space operations."

Shots of the Week

In its first intercontinental-range firing from an underground silo, *Titan II* successfully completed a 4,000-mile trip into its target area April 27. The Martin-built 15,000-mph ICBM was launched from Vandenberg AFB, Calif., by Air Force Systems Command and contractor personnel. The firing was to test the total weapons system operation and to provide missile sub-system data.

Four days later, on May 1, a *Titan I* being launched from a Vandenberg silo exploded before becoming airborne.

Other shots of the week:

- The Air Force launched an *Atlas F* with a Chrysler-built nose cone on a 5,000-mile flight from Cape Canaveral to the vicinity of Ascension Island in a continuation of the Advanced Ballistic Re-entry System (ABRES) test program. The flight, which largely duplicated the initial ABRES test of Mar. 1, was described as "highly successful."
- The Air Force launched a secret satellite from Vandenberg April 26. The satellite, employing a *Thor-Agena* booster, was believed to be one of the *Discoverer* series.
- A *Polaris A3X* was launched April 26 from the U.S.S. Observation Island near Cape Canaveral, but the missile achieved only partial success. First-stage performance and separation were normal, but the second stage of the advanced 2,800-mile missile wandered off course and was destroyed.
- In a fourth April 26 shot, a *Blue Scout*-borne satellite of undisclosed type was launched from Pt. Arguello, Calif. The Air Force did not reveal the purpose of the firing or whether it was successful.

AF Pleads for X-20, ASP

The Air Force's *Military Orbital Development Station (MODS)* and *Aerospace Plane* are of prime importance to the military mission, a Congressional subcommittee has been told.

This emphasis was indicated in testimony before the House Science and Astronautics committee by General Bernard A. Schriever, head of the Air Force Systems Command, who also said the Air Force was reviewing its program at the request of Defense Secretary McNamara. The review, he said, is aimed at determining how the Air Force might revise its efforts to better achieve its military mission capabilities.

While the Secretary indicated special interest in learning how *X-20*

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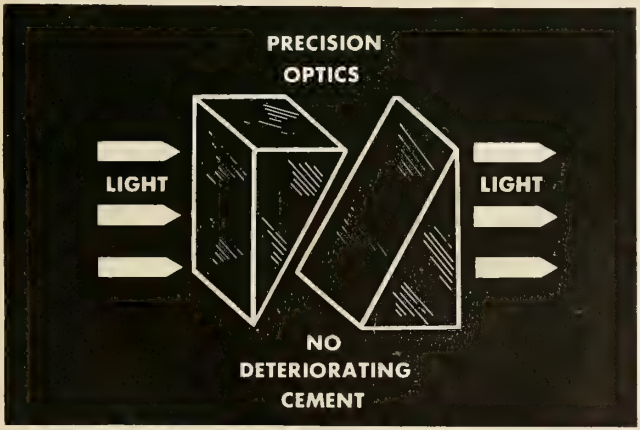

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M/R's 1962 'Product of the Year' Prize

FIRST Missiles and Rockets' *New Product of the Year award was presented by Wayne W. Parrish (right) president, American Aviation Publications, to Robert Bridgforth (left), chairman of the board, Rocket Research Corp., in Seattle recently (M/R, April 29, p. 34). RRC won the plaque for its subliming solid microrocket. At center is Dave Kimball, vice president-general manager of Whittaker controls & Guidance Div., Telecomputing Corp., which makes the microrocket's valves.*

(Dyna-soar) and *Gemini* would contribute, all technological efforts pertinent to the military requirement are being reviewed, Schriever said.

The first AF Five-Year Space Program was forwarded to McNamara last November, with recommendations for approval of specific programs by the Secretary of the Air Force.

Schriever told the subcommittee on manned spaceflight that *MODS* was "of fundamental importance to achieving various military capabilities in space, both manned and unmanned." It would build on technology developed in *Dyna-Soar* and *Gemini*, and provide a space laboratory which would help resolve uncertainties about space military operations. Schriever added that there was no other means of accomplishing some of the objectives, and others would require expensive and time-consuming techniques.

One-a-Day ICBM's

The Strategic Air Command has begun accepting ICBM's at the rate of one a day for the rest of calendar year 1963. With the acceptance last week of the 100th *Minuteman* ICBM at Malmstrom AFB, Mont., the pace of deliveries will pick up. At the end of April, therefore, the U.S. had 280 ICBM's operational, not counting 144 *Polaris* missiles aboard submarines.

By the end of this year, the U.S. will have 525 ICBM's on duty, not counting the increased numbers of *Polaris*. However, observers noted that all the missiles involved were planned and ordered by the Eisenhower administration.

ComSat Corp. Eyes Systems

The Communications Satellite Corp. will spend about one-half to one million dollars in contracts in the near future for research leading to the choice of a satellite system, says Leo D. Welch, chairman of the new corporation.

The first contracts will be for studies to assist the corporation in arriving at design requirements. During this period, the firm also will take advantage of NASA work, he said.

The corporation will start operations with a program-definition phase of about one year, according to Dr. Joseph Charyk, president. He told the House Science and Astronautics committee that a subsequent hardware development program would put the earliest operational system date at about 1967-68.

The operational setup will probably be based on medium altitude satellites, the incorporators told Congress, although a synchronous, 22,000-mile-altitude system has not been ruled out. In answer to Congressional questions, the executives also said that if NASA's funding for synchronous satellite study were not approved, the corporation could not make such a system feasible on its own.

The corporation will contract with NASA on a piece-work basis for research and technology, and the details of reimbursement will be worked out for each instance, the officials said.

First contracts will be awarded before the initial stock offering is made, Dr. Charyk said. The corporation is working on a $5-million bank loan expected to last a year. The first stock issue probably will not come for 15-18 months, he added.

First ARIS Ship Dedicated

The USAF Ship General H. H. Arnold, first of two Air Force Advanced Range Instrumentation Ships (ARIS), was dedicated at Port Canaveral, Fla., May 1.

With electronic equipment more powerful than any land station on Atlantic Missile Range, the Arnold will be used for studies of re-entry vehicles and decoys in areas of AMR where land-based facilities are not available. It can track three targets at one time.

The Arnold will operate out of Capetown, South Africa, and is to be on station after a nine-week checkout. It will be certified for passage through the Panama Canal, allowing its use in Pacific Missile Range as well as AMR.

Mrs. H. H. Arnold, wife of the late five-star general and Army Air Force chief of staff, dedicated the ship. Principal speaker was Gen. Bernard A. Schriever, Commander of Air Force Systems Command.

GPA To Buy Radiation, Inc.

General Precision Equipment Corp. is negotiating possible acquisition of Radiation, Inc., Melbourne, Fla.-based missile/space contractor by one of GP's subsidiaries—presumably General Precision Aerospace.

Under the plan being discussed, all assets of Radiation would go to GP in return for about 296,000 shares of GP common stock (an exchange roughly equivalent to a trade of 3.5 shares of Radiation to one share of GP stock).

NASA Concedes Gemini Slip

The first two-man *Gemini* flight has now definitely slipped into at least the second quarter of 1964, and Russia is expected to complete a multi-manned Earth orbit soon—at least a year before the U.S. does.

NASA Administrator James E. Webb conceded the further slippage and acknowledged the Soviet's advantage on April 27.

Webb, speaking during a panel discussion at a Princeton University alumni meeting in Washington, D.C., said "difficulty in utilizing" the *Titan II* booster and problems with the *Gemini* capsule have put the program behind its recently revised target date calling for a manned *Gemini* shot in the first quarter of 1964.

"No one can forecast now exactly when we will fly *Gemini*," he said.

At the same time, he said Russia appears to be able, thanks to its present booster advantage, to launch a multi-manned orbital flight "a year before we will."

Surveyor Needs Big Boost

NASA officials now believe that a more powerful booster than the *Atlas-Centaur* will be required for later *Surveyor* flights.

Two replacements are being considered and a decision is expected in about six months.

Both alternatives are being studied by NASA in-house as well as by study contracts with private industry.

One concept under review by the Martin Co. under a six month contract calls for a *Titan-Centaur*.

The other, under study by General Dynamics/Astronautics, would use an uprated *Atlas* booster that could provide about the same thrust as the *Titan-Centaur* combination.

F-1 Funds to Rocketdyne

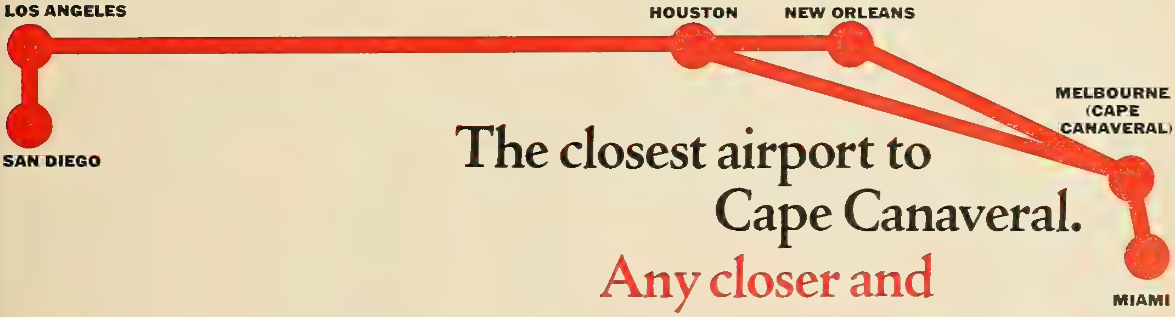
NASA has awarded a $115-million contract to Rocketdyne Div. of North American Aviation Inc. for continued development of the F-1 engine.

The new award is a follow-on to the $19-million letter contract the firm received last year.

The new award will continue development through flight qualification, expected in 1966.

Five F-1 engines will provide 1.5 million lbs. thrust for the first stage of the *Saturn V* booster which will launch the first U.S. manned lunar landing mission.

Here's National Airlines' new thru-jet "Rocket-Run"



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EASTBOUND

	LEAVE	ARRIVE
SAN DIEGO*	12:20PM	
LOS ANGELES	1:10PM	12:50PM
HOUSTON	5:40PM	5:10PM
MELBOURNE	9:00PM	8:35PM
MIAMI		9:37PM

WESTBOUND

	LEAVE	ARRIVE
MIAMI	1:35PM	
MELBOURNE	2:45PM	2:12PM
NEW ORLEANS	3:40PM	3:14PM
HOUSTON	5:00PM	4:32PM
LOS ANGELES	7:55PM	7:00PM
SAN DIEGO†		8:41PM

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At space medics' meeting . . .

Apollo Environment Attacked

Vast majority of physicians oppose pure oxygen; dangers from fire, anemia, effects on vision cited

by Russell Hawkes

Los Angeles—About 200 biomedical experts have expressed nearly unanimous opposition to NASA's selection of a pure-oxygen environment for *Apollo.*

A panel discussion of the comparative disadvantages of pure oxygen and mixed gas systems was held as part of the Aerospace Medical Association meeting here last week. Interviews after the discussion revealed that a large part of the group feels that medical advisors in the Manned Space Program have not insisted strongly enough on adequate physiological research before environmental-system design decisions.

A number of the physicians privately discussed formation of an unofficial watchdog group to insure that medical requirements are not overruled by engineering or political expediency in future space programs.

Possible hazards associated with pure oxygen listed by some of the speakers included fire; long-term anemia; oxygen toxicity, including effects on vision; partial lung collapse; and reduced tolerance of ionizing radiation.

• **Counterattack**—Defenders of the NASA approach, headed by Lt. Col. Stanley White of NASA, pointed out that the danger of bends is greater with a double gas system in the event of a loss of cabin pressure.

White said the U.S. and Russia are both about to experiment with crew operations outside the spacecraft, and the NASA decision to use pure oxygen in the spacecraft gives the U.S. an advantage in these tasks.

The suits probably will have to use a low-pressure pure oxygen system, and the two-gas atmosphere of Russian spacecraft will call for several hours of pre-breathing pure oxygen to prevent the bends. White noted that when one astronaut or cosmonaut opens the hatch to go outside, his partner will also be exposed to the space environment with only the protection of his suit. Thus, if preparations are inadequate and severe symptoms occur, there will be no one to solve the problem.

• **Fire threat**—Spokesmen from the U.S. Air Crew Equipment Laboratory and Pacific Missile Range said that spacecraft fires in a pure oxygen system must be totally prevented.

In experiments at Pt. Mugu, Calif., materials in a 5-psi oxygen environment like that of U.S. spacecraft burn six times as fast, they reported, at a much higher flame temperature and with a lower ignition temperature than in ordinary air. In one accidental fire with men in an experimental pure-oxygen environment, a subject attempted to slap out a fire with his hand only to have the hand burst into flames. When he tried to beat it out on another part of his body, it, too, began to burn.

Air Force space medics told M/R that the oxygen appears to have a saturation effect, and after a period of time all clothing, skin, and other materials become "soaked" with oxygen molecules, and thus fire cannot be smothered out.

• **Long-term damage?**—Dr. George Albright of Republic Aviation Corp. suggested that NASA should take a look at the long-term effects of a pure oxygen system rather than merely concerning itself with survival for the duration of the mission.

He cited evidence that the use of pure oxygen can produce a long-lasting deterioration of health. Republic placed three groups of human subjects in simulated spacecraft atmospheres for two weeks, Dr. Albright said, and of those in pure oxygen more than two-thirds suffered anemia lasting between five and seven months. In one case the anemia was so severe that the subject lost one-third of his blood volume. Urine specimens also showed evidence of kidney pathology.

The anemia appears to be caused by the destruction of an enzyme known as glucose-6 phosphate dehydrogenase, which normally resists the tendency of red blood cells to oxidize. A small part of the population, usually of the Mediterranean and Negro races, is particularly prone to this sort of anemia.

NASA decided not to fund a follow-up study of long-term effects on the Republic subjects on the grounds that no base-line data for such a study had been collected before the test, when the problem was not foreseen. Republic physicians argue that general norms in the population could be used as reasonable baselines, since data from the subjects far exceeded these values. Republic is conducting the follow-up study with company funds.

• **Switch urged**—Dr. James Waggoner of the Garrett Corp., life support system contractor for *Apollo,* estimated that it is not too late for NASA to switch to a double-gas oxygen-nitrogen system for *Apollo.* He said development of such a system was 50% complete at the time NASA chose the single-gas system. He conceded that the double-gas system involves slight weight and reliability penalties, but declared that these should not pose insoluble problems.

Dr. Rufus Hessburg of Air Force Systems Command, about to join NASA, suggested that U.S. space programs should back away from single-gas systems only reluctantly, because of the operational advantages they possess. He said, however, that biomed experts must insist on more cooperation from engineers in meeting physiological requirements.

He observed that some Navy experiments have shown that there is strong reason to believe that prolonged exposure to pure oxygen degrades eyesight. In vehicles such as *X-20 Dyna-Soar* the astronaut must function as a pilot during the landing phase, and such a degradation could not be accepted. *X-20* has a double-gas system, 60% nitrogen and 40% oxygen.

• **Data management?**—A number of the biomedical specialists interviewed by Missiles and Rockets complained that NASA suppresses information to prevent opposition from developing. One doctor said that when NASA was inclined to favor a two-gas system, it would not allow publication of data on bends, which are a hazard with double-gas systems. Now that single-gas has been selected, he charged, NASA is opposing collection or publication of data that could be used by opponents of the decision.

When anemia was first detected in the Republic subjects, the company and NASA decided to keep the facts secret to avoid alarming the subjects. A McDonnell Aircraft Corp. scientist said the security was so tight that it was impossible to obtain any of the results for use in Project *Gemini.* ■

SHRIKE anti-radiation missile (ARM) in flight test at Naval Ordnance Test Station, China Lake, Calif.

Radar destroyer . . .

Shrike Program Being Pushed by Navy

Highly successful tests mark accelerated development; Air Force plans large procurement for tactical aircraft

by Frank G. McGuire

THE NAVY IS PUSHING development of its *Shrike* anti-radiation missile (ARM) to achieve fleet availability at the earliest possible date. In the wake of a successful test program for the radar-buster, the Air Force also has planned a large procurement of the weapon.

Shrike is expected to be extremely valuable in combatting air-defense setups similar to the Soviet system now installed in Cuba. That still-active military threat is viewed as part of the reason both AF and Navy want such an effective tactical weapon in use as soon as possible.

An anti-radiation guidance system for *Bullpup*, allowing it to sense and home on enemy electromagnetic radiation transmissions to destroy radar installations, has been considered, but the *Shrike* is felt to be a better approach. *Shrike's* extreme accuracy permits it to do its job with a relatively small conventional warhead.

Technical director for the project is the Naval Ordnance Test Station at China Lake, Calif., with Texas Instruments, Inc. serving as principal contractor. TI is supplying components and subsystems.

• **Simple but versatile**—The missile is considered more sophisticated than *Sidewinder*, another highly successful development by NOTS/China Lake, but is still not considered a highly complex weapon. It will seek out and destroy enemy radar installations operating in the X and Y bands, and the newer C band. It will also home on CW radar, chirp radar, frequency agility systems and other types which might be encountered.

Physically a near-twin to *Sparrow III*, *Shrike* has two sets of aerodynamic control surfaces for a total of eight. The main set is about at the midsection, and another set is at the tail.

Navy-built guidance systems for *Shrike* have been used for initial flight tests, and TI-built guidance systems are now being introduced into the program. The entire first year's buy of the missile has been assigned to the R&D phase of the program, and follow-on purchases will go to fleet and Air Force units.

Navy attack aircraft slated to use the missile include the A5, A6 and A4-E. Compatibility with NATO aircraft is not expected to present any problems, and although no plans have been made yet, NATO is expected to purchase *Shrike*. The missile has a solid-propellant rocket motor, but a Department of Defense Research and Engineering spokesman said the missile is not wed irrevocably to the solid rocket.

The FY '64 budget request will be used to fund the full program. Previous money has been used only for component procurement in the development phase. This, coupled with the planned operational date in FY '64, indicates unusual haste in placing the missile in service.

• **Contract situation**—TI has received two contracts for *Shrike*, a $1.57-million award for engineering and manufacturing services, and $1.8 million for continued R&D.

Shrike, formerly referred to as ARM, was programmed in FY '63 for roughly $2.5 million. It is designed to fill a gap partly caused by cancellation in July, 1961, of the *Corvus* missile, which is believed to have had an anti-radar mission. The Navy said at the time that *Corvus* was cancelled because it was more limited in its application than other systems under development.

Decision of the Air Force to buy *Shrike* means a larger production run will be ordered, lowering costs per missile. The Air Force is now buying all Navy air-launched missiles—*Bullpup*, *Sidewinder* and *Sparrow*—as well as *Shrike*. Final deliveries on the FY '64 buy are expected in June, 1965.

Final testing of the missile will be at Pt. Mugu, Calif., with intermediate evaluation at China Lake. Once operational status is reached, both Navy and AF are expected to buy in large quantities. DOD officials have indicated *Shrike* would be expended in large numbers during any sizable military operation. ■

Following Army, AF . . .

ARPA Taking Re-entry Launches West

Trailblazer I program will be moved to White Sands in the fall; Green River firing site to be shared with Air Force

THE ADVANCED Research Projects Agency is following the Army and Air Force lead in shifting a major portion of its ballistic missile re-entry studies westward from East Coast launch sites.

Following the Air Force decision to shift part of its Advanced Ballistic Re-entry System (ABRES) launches to the Pacific Missile Range (M/R, April 15, p. 12), ARPA will move its *Trailblazer* target vehicle launches to White Sands Missile Range (WSMR), N.M., next fall. The agency's extensive program for studying the physics of re-entry bodies at NASA's Wallops Island, Va., station is slated to include eight more launches of *Trailblazer I* vehicles before the move.

At the same time, it was learned that the Air Force will conduct firings of some of its ABRES nose cone designs at WSMR. Also expected to begin later this year, the ABRES firings will use WSMR as an instrumented impact area, with launchings planned from Green River, Utah.

Air Force sources said the low-cost, lightweight *Athena* solid-propellant booster, being developed from off-the-shelf rocket motors by Atlantic Research Corp., will carry at least 77 special payloads down the range.

The Green River facility will be used jointly by ARPA and the Air Force for the re-entry studies. Similarly, the Army will be firing its *Pershing* missile from Fort Blanding, Utah, and Fort Wingate, N.M., into WSMR.

The Green River facility will include a safety area five by eight miles adjoining the launch sites for use in case a vehicle malfunction requires an early flight termination before full velocity is achieved.

Atlantic Research Corp. will be the AF contractor for the Green River site, and will lease existing facilities at the site from Union Carbide Nuclear Corp., to be modified at an estimated $500,000. Additional government facilities to cost an estimated $1.5 million will be built by ARC under the direction of the Corps of Engineers. The Air Force has released funds to the Army for the project.

- **ARPA at WSMR**—Much of the ARPA effort at White Sands will be carried out with the *Trailblazer II* booster, an improved, higher-payload vehicle supplanting the *Trailblazer I*, now being used at Wallops Island. The improved vehicle can carry a 40-50-lb. payload to the required re-entry speeds, as contrasted with the 2-lb. payload of the earlier version.

Trailblazer I is a six-stage vehicle using solid-propellant rockets. Three rockets are fired on the upward arc to attain an apogee of 200 miles; three more are fired so that the payload re-enters the atmosphere at very high speeds toward the tracking instrumentation, radars, and telescopes.

Trailblazer II uses only four stages, two for each half of the trajectory, and its higher-weight payload will provide much more data per flight.

A 48-in. spectrometric telescope now located at Wallops will be moved to WSMR when the program shifts west—which will be determined by progress experienced in the Wallops launch schedule. Other instrumentation and radar equipment will remain at Wallops.

An estimated $20 million worth of radar is now being set up and readied at WSMR in preparation for the program, including AMRAD (ARPA measurements radar). AMRAD has specific applications to ARPAT (ARPA terminal technique), which is an attempt to improve the ability to intercept and destroy enemy ballistic missiles during the terminal phase of flight.

The Army is already conducting considerable work in this line with its *Nike-Zeus/Nike-X* development work at WSMR. Therefore, much of the nation's antimissile effort is now connected closely with the White Sands complex, in addition to the Army and Air Force activity on the Pacific Missile Range, and the remaining work in this area using the Atlantic Missile Range.

The ARPAT studies as they apply to an interceptor vehicle stress an infrared terminal guidance system in the missile itself, rather than the command-guidance approach followed in the *Nike* series. The ARPAT interceptor vehicle will thus depend on considerably different radar techniques than does the *Nike* family.

One Defense Department spokesman noted that the Pentagon "is hoping to come up with simpler missiles and more of them" in its attempt to develop an alternative to the *Nike* approach which is cheaper, more effective, and closer in time.

Despite the small payloads involved, program spokesmen say both NASA and military people have a vital interest in the efforts.

"The importance of the continuing re-entry experiments can hardly be overemphasized as it relates to NASA manned space efforts, the entire antimissile program, and other Space Age progress," commented a NASA official.

The radar and spectrometric telescope now in use at Wallops Island is being operated for ARPA by MIT's Lincoln Laboratory. Included in the data being gathered are amounts of optical and infrared radiation emitted during re-entry, as well as variations in reflected radar signals on different frequencies. ■

Titan II Shakes Minimized

TITAN II program spokesmen have deplored concern over a "pogo-stick" vibration characteristic in the booster, which has been giving NASA some cause for anxiety.

Reportedly severe enough to prevent the two *Gemini* astronauts from reading the instrument panel for a period up to 20 seconds soon after liftoff (M/R, April 22, p. 15), the vibration is now claimed to have been reduced to one-fourth its previous severity.

Sources close to the hassle say the average acceleration for the vehicle is 3 g's, and the longitudinal stretch/contract action of the vehicle causes this to vary, from the astronaut's viewpoint, from 3.8 maximum to 2.2 minimum g's during this phase of flight.

This problem, coupled with schedule alterations, funding difficulties and other holdups, has contributed to slippage in the *Gemini* program amounting to about nine months, but the vibration difficulty is expected to be overcome before it contributes to any further skidding of the schedule.

Effective next month . . .

Navy Overhauls R&D, Procurement

New offices will review programs before presentation to McNamara, insure compliance with program-package concept

THE KENNEDY Administration will send to Congress shortly a reorganization plan for the Navy Department including a vast shakeup in the management and flow of research and development programs.

The plan was originally scheduled for delivery to both houses of Congress on May 1, but a Navy spokesman said that implementation problems would delay it for a short period.

It has already been approved by Secretary of Defense Robert S. McNamara and Navy Secretary Fred Korth. Details of the reorganization were revealed by Korth recently in testimony before the House Appropriations Committee.

• **New order**—Major changes which will affect Navy procurement and R&D programs include:

—Establishment within the Office of the Secretary of the Navy of a Plans Appraisal Office. The office will review all service programs before their presentation to McNamara to insure that they fulfill the broad guidelines laid down at DOD level. The office is designed along the same lines as the current DOD management policy which centralizes decision-making authority in the Office of the Secretary.

—Establishment in the Office of the Chief of Naval Operations of a Plans and Programs Office designed to insure that the Navy fulfills and adheres to DOD's five-year program package management concept. This provides that all development programs must have detailed plans covering a five-year period, which lay down scheduling, development milestones and funding requirements.

—Creation of a new office, the Chief of Navy Support, which will have direct control over the Bureau of Yards and Docks, Bureau of Naval Weapons, Bureau of Ships, and the Bureau of Supplies and Accounts. The new office will report directly to Secretary Korth. The Office of Naval Material, which currently oversees Navy contracting and procurement, will be abolished and the functions of the Bureau of Naval Personnel and the Bureau of Medicine and Surgery will remain unchanged.

• **Month to ponder**—Plans call for submission of the reorganization to Congress under terms of the 1958 DOD Reorganization Act, which provides that the changes become effective 30 days after submission if neither house of Congress has taken steps to disapprove them. Changes will be considered first by the Armed Services committee.

Another change included in the organizational shakeup is the establishment of a Fleet Activities Command under the Chief of Naval Operations. The new office is designed to improve the coordination of the direct fleet support effort at naval bases in the United States.

Other management changes include:

—The Bureau of Yards and Docks is given responsibility for maintenance at all Navy bases and installations now handled by the various bureaus.

—The 14 regional Navy District Commanders will be assigned to represent the Fleet Activities Command in the coordination of fleet support activities. This will be in addition to their current duties as heads of reserve units, public information, and representatives of the Chief of Naval Operations and Korth in their areas.

Telstar II Equipped to Handle Radiation

AT&T's *Telstar II* satellite is to be launched this week in an attempt to determine how communications satellites can avoid or overcome effects of the radiation belts surrounding Earth.

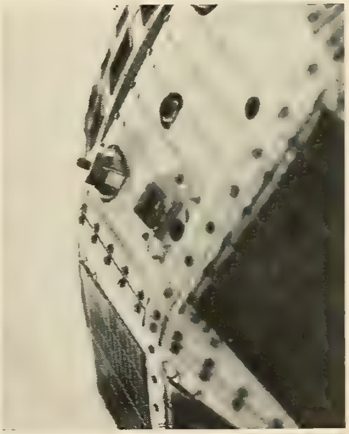
If successful, the satellite also may provide the first television link between the U.S. and Japan.

Earliest date for the flight is May 7. The satellite will be launched by NASA from Cape Canaveral, using an improved *Delta* booster.

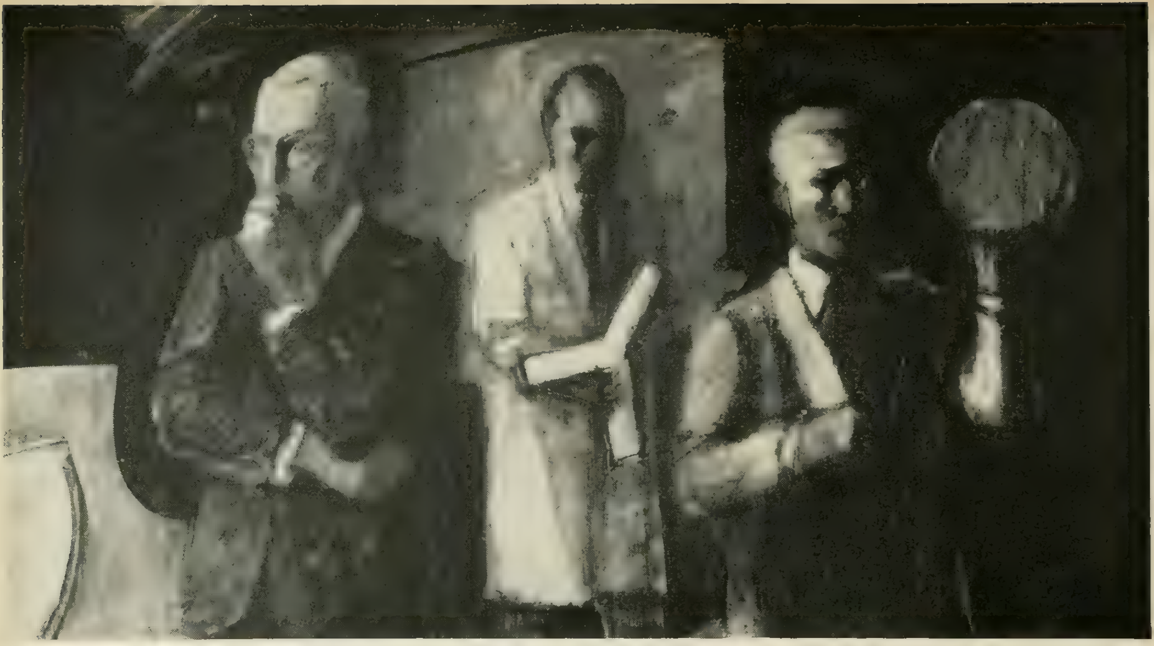
In an effort to reduce the radiation hazard which shortened the lifetime of *Telstar I*, the new satellite will be equipped with new "evacuated" transistors. These transistors—sealed in a vacuum—should escape the radiation caused by ionization of gases which plagued *Telstar I* transistors.

Another major change in the mission profile calls for a much higher orbital altitude, where *Telstar II* should encounter less radiation than its predecessor. It will orbit the Earth at a perigee of 575 miles and an apogee of 6,560 miles with an orbital period of 221 minutes. *Telstar I's* orbit ranged from 592 miles to 3,531 miles with a period of 158 minutes.

The higher apogee of *Telstar II* also will provide longer mutual visibility between AT&T's ground station at Andover, Maine, and ground stations in Europe. It will likewise supply some mutual visibility between Andover and Japan. This could permit the first transmission of TV pictures between Japan and the United States.



CLOSE-UP of Telstar II panel shows gold scatter dome covering electron detector. Device measures electrons in energy range from 750,000 to two million electron volts, compared to 250,000 to two-million for Telstar I.



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SYSTEMS ANALYSIS Analysis and simulation of complete nuclear power plants to develop reliable, unattended, completely automatic control and instrumentation systems including reactor kinetics, dynamics, hazards and reliability analysis.

REACTOR SHIELDING Experimental and analytical shielding techniques and materials development for both central station and compact power reactors.

STRESS ANALYSIS Experience in either thermal stress or dynamic stress resulting from shock and vibration loads in aircraft structures. Responsibilities will entail design support for compact nuclear power plants for space applications including review of all designs with respect to stresses resulting from thermo gradients and transients, static loadings, and vibrational and shock loadings.

FUEL ELEMENT DEVELOPMENT Studies of the behavior of nuclear fuel materials and elements under simulated reactor operating conditions. These studies include both in-pile and out-of-pile tests, fuel evaluations, and projection to predict actual operational behavior. Also, development of processing and fabrication techniques for fuel elements, including melting, rolling, powder metallurgy processes, joining, etc. Results from these studies will contribute toward the improved design of fuel elements for the reactors under development.

Contact: Mr. H. E. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, Calif.

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Technical Countdown

ELECTRONICS

Defender Harvest Due in Three Years

In three years, the Defender program should provide 95% of the knowledge required to understand and interpret re-entry physics phenomena, predicts Lt. Col. K. B. Cooper of DOD's Advanced Research Projects Agency. Started in 1958, the program is currently funded at about $510 million annually, with the major portion allocated to PRESS, the Pacific Range Electromagnetic Signature Studies. At the present time, Cooper told a press group at Wallops Island recently, problems of discrimination have not been solved sufficiently to justify an operational weapons system which depends on such technology. However, he asserted, preliminary studies have indicated that radar techniques show promise for mid-course discrimination. Such techniques, probably in use in 2-3 years, will yield data showing size and shape of incoming vehicles.

Langmuir Probes to Aid Re-Entry Studies

Air Force Mark VI re-entry vehicles to be used in upcoming launchings from Vandenberg AFB will be instrumented with an array of Langmuir probes to measure electron density and temperature conditions in the vehicle flow field during re-entry flight phase. The equipment, developed for Ballistic Systems Div. by Geophysics Corp. of America under a $500,000 contract, is also expected to determine electrical charge potential of the vehicle in the high-speed stages. GCA says the antennas and associated internal circuitry to be used in the Mark VI flights are an outgrowth of earlier sounding-rocket measurement devices developed by the firm for ionospheric electron density measurement. The airborne probes are actually adaptions of equipment first developed by Dr. Irving Langmuir (1881-1957) to probe ionized gases.

Air Force Supports Superconductive Generator

Under a recently awarded Air Force R&D contract, Dynatech Corp. will continue development of a superconducting generator. Begun as a company-funded program in 1961, the effort is directed toward producing a generator employing a 3600-rpm, 1-in.-dia. rotor. The rotor will contain a two-pole field solenoid, wound with 10-mil niobium zirconium wire. The stator uses the same wire (20 mil), three-phase wound. Output will be in the ¼ to ½-kw range, the company disclosed.

Superconducting Energizer Revealed

By trapping and sequentially moving a "packet" of magnetic-field lines, a superconducting magnet can be energized without a large power source. This approach permits stopping or altering field strength without endangering the magnet. Developed by Avco's Everett Research Laboratory in Massachusetts and revealed for the first time at the recent American Physical Society meeting in Washington, the method is used in large systems normally requiring several thousand amperes of energizing current. Now, Avco says, currents up to only 50 amperes are required regardless of the size of the superconducting magnet. Under study for 2½ years, the new system has resulted in development of magnets with field strengths up to 50,000 gauss. Operating in liquid helium, the magnets require up to 150 miles of fine niobium-zirconium wire for the coils.

Charting the Re-entry Glow

The glow of a space vehicle as it re-enters the Earth's atmosphere may be measured by a device developed by scientists at Armour Research Foundation of Illinois Institute of Technology. Called a "multi-channel near-ultraviolet and visible spectrograph," the instrument will have quartz or glass fiber rods connected at different points on a nose cone. The on-board spectrograph will record the spectra from the different locations, and an analysis of the film will yield the spectral luminosity profile.

MATERIALS

Laser Vapor Deposition Studied

Selenium, tellurium, and arsenic trisulfide have been vapor-deposited from fine powder samples using a pulsed laser beam as a heat source. Scientists from Bausch & Lomb and the University of Rochester have been cooperating in a research project to determine the mechanics and characteristics of such vaporization. They have been using a ruby laser with a nominal 3-joule-pulse output. Material samples were pulverized (and in some instances mixed with carbon) to minimize surface reflection of incident energy.

MRC to Study Ceramic Deformation

Materials Research Corp., Orangeburg, N.Y., will carry out an Air Force-funded study on deformation mechanisms present in ceramic materials. The effort will concentrate on the behavior of the grain boundary area. The firm says earlier studies showed that loss of strength at elevated temperatures was directly related to behavior at this point. MRC is preparing high-purity ceramic bicrystals for use in the study, which ultimately is aimed at improving the high-temperature structural or load bearing applications for ceramic crystals.

Army To Fund More T-E Research

Research leading to development of fossil fuel-fired thermoelectric generators with power ratings in the range of 25-500 watts will be performed at RCA's Electron Tube Div. in Harrison, N.J., under a one-year $100,000 contract from the Army's Electronics R&D Lab at Ft. Monmouth. RCA claims recent development by the firm of suitably doped silicon-germanium alloys represents a major breakthrough in T-E technology. This material is now being used in SNAP-10A modules.

SPACE MEDICINE

50-Mile Hikes Obviated

Astronauts probably will need only a small amount of exercise to preserve muscle integrity and prevent bone rarefaction in weightlessness. A cyclic regimen of isometric exercises appears ample to counter detrimental consequences of even lengthy bed rest, an Air Force study called "Project Strong Bones" indicates.

PHOTOGRAPH of Humason 1961e taken last July by Francois Dossin at Haute Provence, France. This new and unusual comet, with a 1-million-km.-dia. coma, shows great activity, even far from the Sun, and spectra of only ionized material.

space exploration

Scientists Plan Missions to Comets

NASA, industry, European experts study launch of 'ice' satellites to simulate comets; Encke probe in '64 contemplated

by William Beller

COMETS MAY SOON be simulated by satellites and pierced by space probes. These nebulous astronomical bodies are now thought to hold the only unaltered record of the beginnings of the solar system.

The new interest in comets is reflected by work under way at the National Aeronautics and Space Administration. Having embarked on an aggressive in-house effort concerned with artificial comets, together with a program of comet-probe research, the agency also is spending several hundred thousand dollars for contracted research on low-temperature chemistry and other projects related to comets.

At the same time, the European Space Research Committee at the urging of famed Belgian astronomer Dr. Pol Swings of Liège, is considering launching "ice" satellites as a means for analyzing the behavior of comets and thereby deducing the life cycle of the universe.

Even industry is studying how to explore a comet. Space Technology Laboratories, Inc., for instance, recently completed a two-volume study for NASA showing that a comet probe is practicable. The company noted at the same time that there will be an opportunity to intercept the comet Encke in the summer of 1964, when it will pass relatively close to Earth.

• **A primitive Earth**—Comets until a few years ago were considered astronomical curiosities and were studied mostly as an exercise in orbital mechanics. Then Dr. Fred Whipple, Harvard University astronomer, together with Nobel prize-winner Dr. Harold Urey, and later Dr. Bertran Donn, Goddard Space Flight Center astronomer, suggested that since the bodies are cold objects and have always been cold, they probably haven't changed much since the planets were formed.

Earth, on the other hand, has been thoroughly eroded and shows no known marks of its original formation. The Moon also has suffered erosion through meteorite bombardments, solar radiations, and isostatic adjustments of its surface.

"Comets in a sense were put into a deep freeze," says Donn, "and now as we look at them we are seeing objects that may answer certain questions about the way planets were formed and large celestial objects accreted."

Despite the importance of comets, very little is known about them. Their brightness can be measured, but their mass is uncertain by a factor of one million. They are seemingly capricious bodies that travel highly elongated orbits around the Sun, sometimes out as far as 1000 astronomical units. There is suspicion that some non-periodic comets may not be members of the solar system, but this view is a minority one.

• **Coma and tail**—A comet is made up of a relatively small, bright nucleus surrounded by an exceedingly large cloud or coma. When the comet is near perihelion, the coma or head shrinks while the tail of the comet stretches out enormously. This is caused by solar energy driving material out of the head. The tail of a comet always points away from the Sun.

A comet's head sometimes vies with the stars. In 1811, for instance, the head of the largest comet ever measured was calculated to be 1,255,000 miles in diameter—about 50% larger than the Sun. Its tail stretched out 110 million miles—more than the distance out to the Earth's orbit.

Despite the enormity of the head of even a typical comet—the smallest is about 10,000 miles in diameter—its nucleus where its mass is most dense is quite small. At most, it is a few hundred miles in diameter. If it were much larger it would have a perturbing effect on planets, but no such effect has ever been observed.

Most estimates place the diameter of an average nucleus at only a few miles.

● **Nucleus of ice**—A fundamental question concerns the structure of the nucleus. Swings asks if it is made up of a single bloc of ice, or of a few blocks, or of a multitude of relatively small solids whose overall diameter might only be a few yards.

He also asks whether the surface of the nucleus is made up of fairly clean ices, or of a mixture of ices and "dirt," or mainly of meteoritic dirt. What are the magnetic properties of the nucleus? And what are the temperatures on the illuminated and dark sides?

Another scientist wants direct exploration of a comet. "An enormous, if not definitive, insight concerning the nucleus and the evolutionary problems of comets could be gained by a space probe made to land on a cometary nucleus," says Whipple. He sees "cores of the nucleus . . . stratified like geological sedimentary strata, (which) should give the oldest and least disturbed material record of ancient processes."

The coma and tail of a comet are so nebulous even a dim star can be seen through them with only rarely any measurable attentuation of its light. The mean-free-path of a molecule near the nucleus has been calculated to be about 600 miles. In this region, then, the pressure is about equal to the vacuum drawn by the best chambers on Earth—10^{-10} mm Hg. In a comet's tail, the mean-free-path is a million miles.

Donn brings up an important question about free radicals in the coma. Observing that they show up close to the nucleus, he asks why they appear so soon. Laboratory studies so far have not revealed an efficient mechanism for generating radicals. He suggests that a mechanism might not be needed because the radicals may be trapped in the nucleus at the comet's low temperature —less than 200°K—or compounds might dissociate in the nucleus in a way far more efficient than we can perceive; or chemical reaction might occur near the surface of the nucleus to produce the radicals.

● **Artificial comet**—Of the two ways to examine comets, Dr. Robert Fellows believes the artificial-comet method is closer at hand. Fellows, NASA's chief of chemistry programs in the office of geophysics and astronomy, says, however, that the comet probe may be as much as a decade away.

Swings is urging that an artificial comet be sent up soon. The first one "should probably be made of a single kind of ice, such as CO_2 or NH_3," he says. He recommends that a later satellite be made of a mixture of ices of the probably parent molecules: H_2O, NH_3, and CO_2 with an addition of meteoritic material.

He estimates that a one-ton orbiting artificial nucleus would release enough gaseous molecules to give rise to an observable artificial cometary head; it could be studied spectroscopically and photometrically.

"Comparison of the spectra of the artificial and actual cometary heads would enable us to draw valuable conclusions as to the chemical composition of real comets," he says, "and would provide clues for the preparation of subsequent experiments."

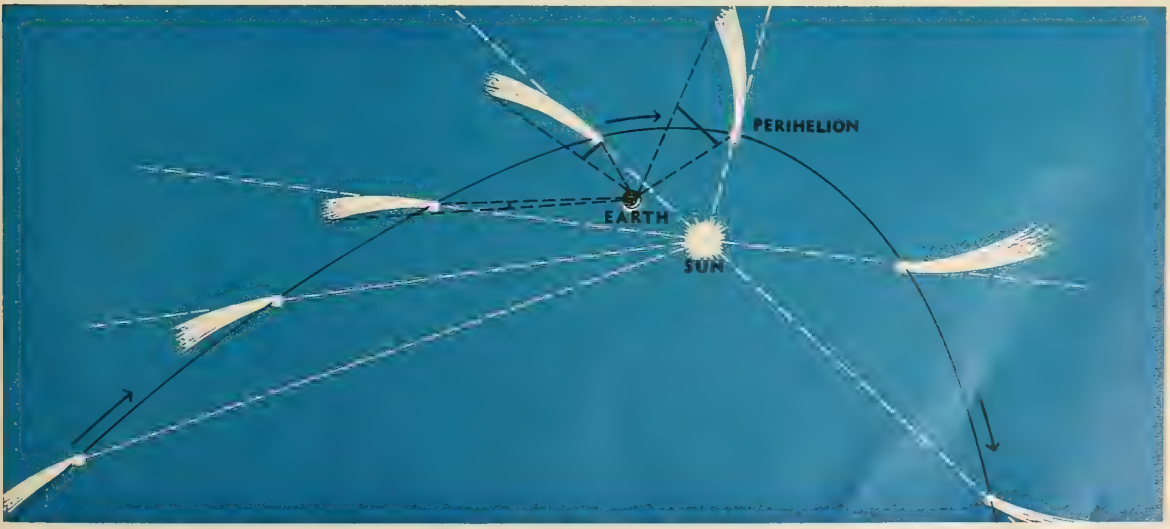
A fascinating sidelight is added by Donn. He foresees use of comets themselves as space probes, once their characteristics are known. The comet would respond to its environment—solar, thermal, and corpuscular radiations, and the interplanetary medium—and as a consequence could be used to measure them. One astronomer, in fact, already has tried to choose between competing theories of the "solar winds" on the basis of the actions of distant comets. Unfortunately, comets are not well enough understood for the scientist's conclusions to stand up.

● **A probe to Encke**—On July 13, 1964, the comet Encke will be about 24 million miles from Earth. A probe powered by an *Atlas-Agena B* would have sufficient velocity to be sent through the comet, according to a report by Space Technology Laboratories, Inc.

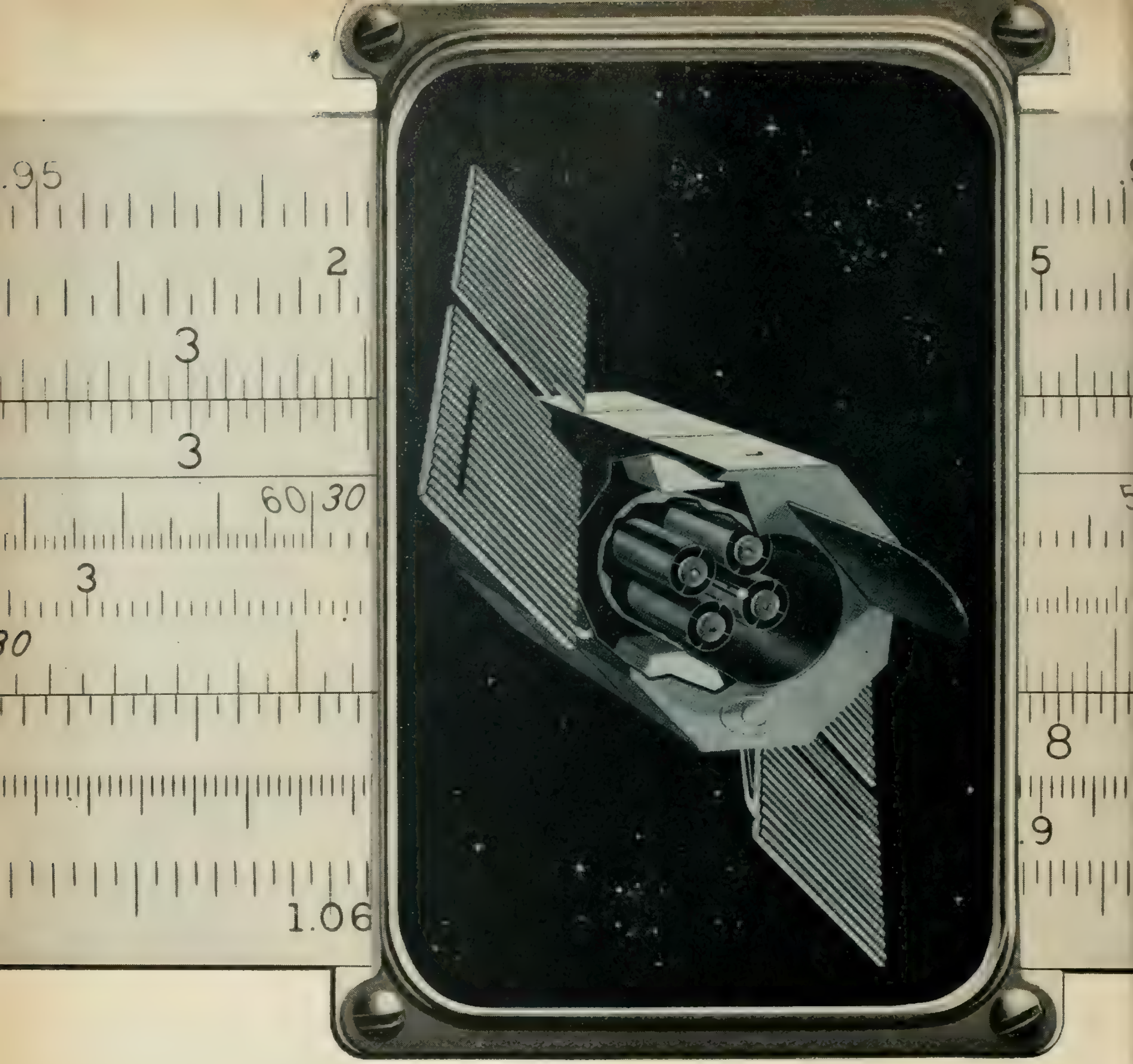
Probes to penetrate Encke may be launched from Cape Canaveral three or four months before the intended intercept. The STL report, written by Dr. J. C. Lair, affirms that much of the needed technology is at hand. It was found that a low-energy orbit to Encke will require burnout velocities of about 40,000 fps; and higher-energy orbits will require less than 42,000 fps.

By way of comparison, Earth escape requires about 36,000 fps, and a Venus probe about 38,500.

COSPAR (Committee on Space Research) and the International Astronomical Union both support the concepts of artificial comets and comet probes. With such scientific backing and NASA's support, the prospects are good that a strong, worldwide cometary research program will be forthcoming—particularly in view of its potential payoff. ■



SOLAR ENERGY turns comet's tail away from Sun. Note how location of observer can change the tail's apparent length.



EMR electro-optics make space

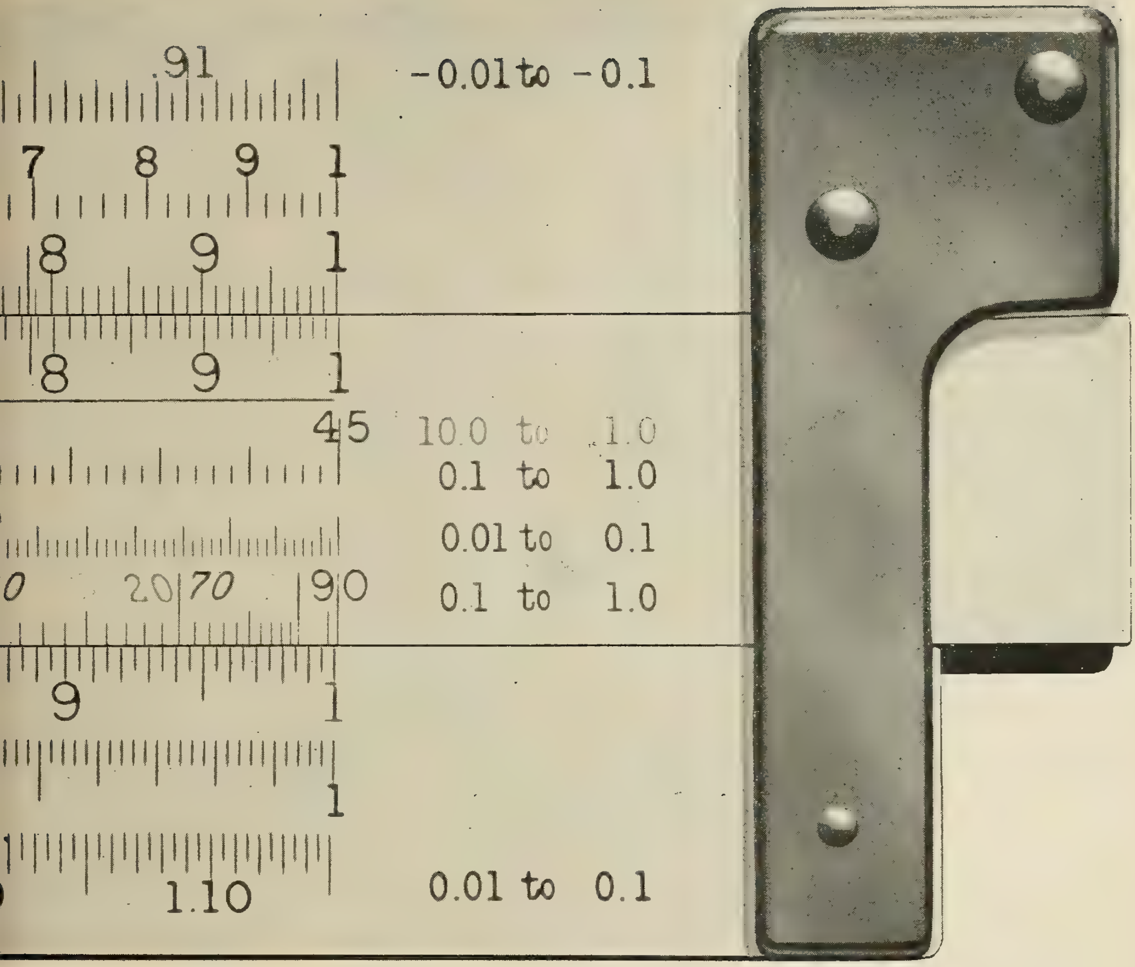
EMR progress in electro-optical techniques may soon transform satellite-borne television into a basic tool for space research.

Special developments for Project Celescope, the Smithsonian Astrophysical Observatory's portion of the NASA Orbiting Astronomical Observatory, are typical of EMR's achievements. For Celescope, EMR has developed an ultraviolet television photometric system of unmatched versatility. Consider these features:

New developments in UV techniques. Large precision optics, coupled with highly sensitive UV television detectors, will give astronomers their first comprehensive all-sky stellar survey in four broad UV bands ranging from 3000 Å to 1100 Å. EMR's electro-optical technology will compile UV profiles of more than 100,000 stars into a new map of the heavens. Hot stars down to 12th magnitude will be observed in a one-year earth-orbit program.

Choice of digital or analog TV. The EMR system permits accurate real time data acquisition by the use of digital television techniques coupled with PCM transmission. Remote operation is provided by digital storage of the TV data, followed by PCM transmission on command. A conventional, slow scan analog TV mode is also provided.

Flexible command and control system. EMR equipment permits manual operation of the four camera system via ground



television as versatile as a slide rule

commands; automatic remote operation via on-board stored commands; or automatic real time operation via ground computer command-control.

Unprecedented reliability. There is better than 95% probability that Celescope's electronic system and at least one TV camera link will operate successfully for one year in orbit.

Difficult problems in surveillance or reconnaissance, long-range restricted bandwidth video systems, and electro-optical measurements in any part of the spectrum are EMR specialties.

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Systems Division **Sarasota, Florida**

EMR

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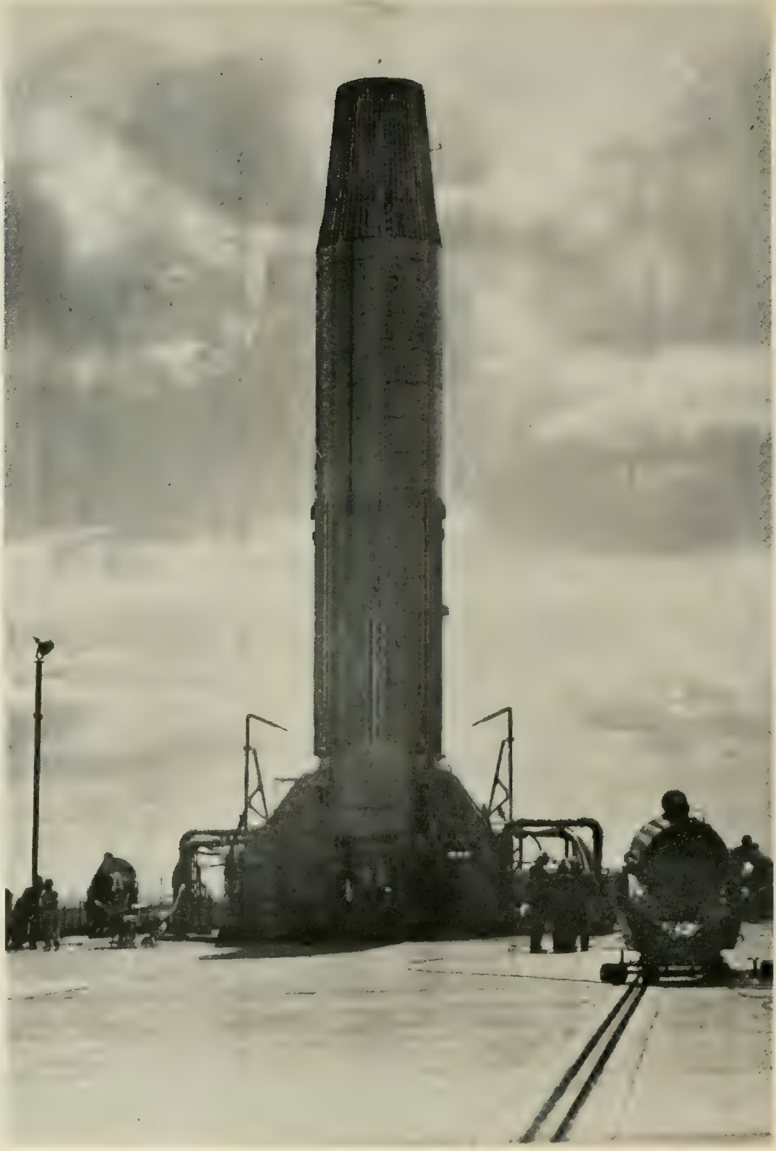
The Cover Photo

M/R First U.S. Journal With Cover Via ComSat

Test with NASA's Relay produces two high-quality pictures; British, RCA, ITT, AT&T cooperate



De Havilland Propellers' Blue Streak at Spadeadam

MISSILES AND ROCKETS has completed the first successful transmission of magazine photos from Europe to the U.S. via an orbiting communications satellite, NASA's *Relay*.

With this week's issue the magazine also becomes the first U.S. publication to feature such a photo on its cover.

The successful transmission was undertaken on April 25. During the 30-minute pass of the RCA-built satellite, two photos—one of the British *Blue Streak* missile (above) and the other, the mounting of the English Electric *Vigilant* antitank missile by a British soldier in Norway (see cover) were flashed from London to the U.S.

The experiment was attempted by the M/R staff to test the practical applications of communication satellites to the publishing business. If product quality is the determining factor, comsats are here to stay.

The pictures were received in good condition and all participants in the operation performed perfectly.

- **Itinerary**—The facsimile transmission originated in the offices of the British General Post Office in London. It was sent via landline 300 miles to the Goonhilly Downs ground station for transmission to *Relay*. The return signal from the satellite was received at the ITT ground installation at Nutley, N.J.

From there, it was transmitted by RCA Communications via AT&T landline to New York, where the facsimile was recorded and processed in RCA's Program and Radio Photo section.

The pictures were transmitted on pass No. 1035 of the satellite, which was launched on December 13, 1962.

After transmitting synch-pulses between British and U.S. photo facilities and setting up frequency limits for the black and white photographs (between 1500 and 2300 cps), receipt of the first picture began at 4:43 p.m. EST and ended at 5:08 p.m. EST.

The test was made under a NASA policy which permits qualified individuals, firms, and institutions to use both the *Relay* satellite and its various ground stations free of charge to conduct approved experiments testing the feasibility of communication satellites.

All advertising is banned and the experimenters must make their own arrangements with private carriers for landline transmission. ■

Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand — getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at γ= −6° to touchdown?

Curves Provide Key

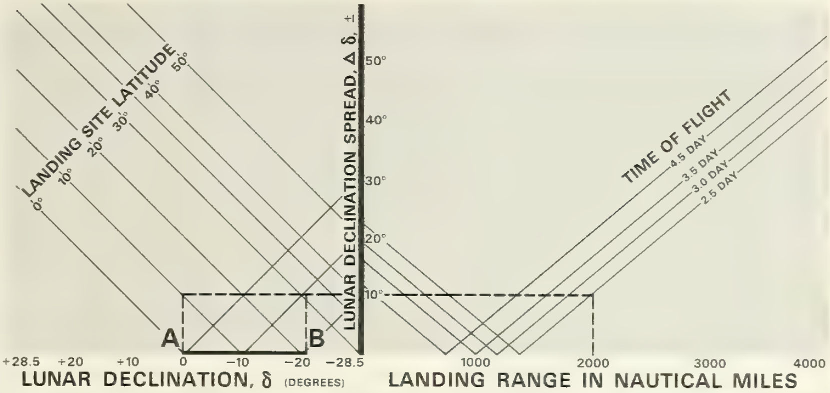
The curves at upper right provide the key. Window AB describes the range of lunar declinations, from +0.5° to −20.5°, acceptable for returning to an earth landing site at a latitude of +10°, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at γ= −6° to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of −10°. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

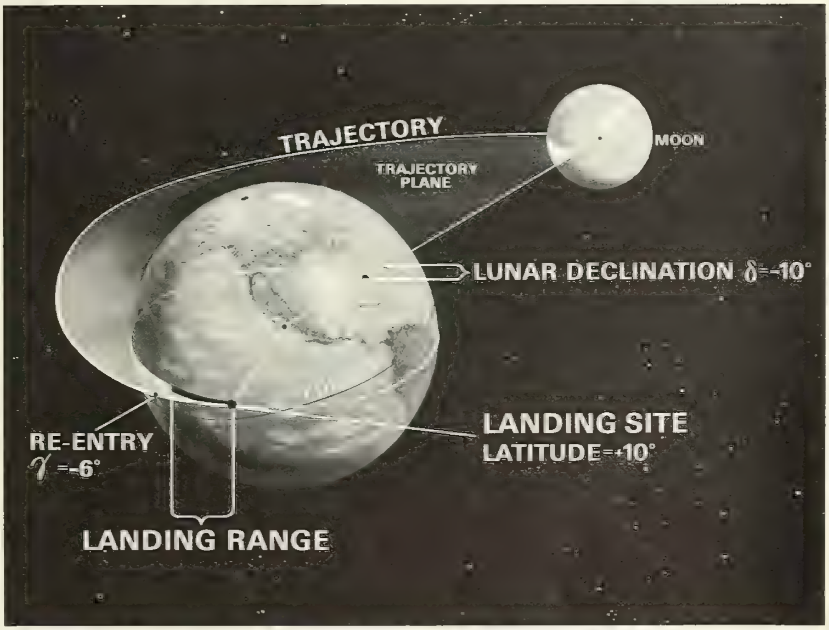
Variety of Opportunities

At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far-ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.

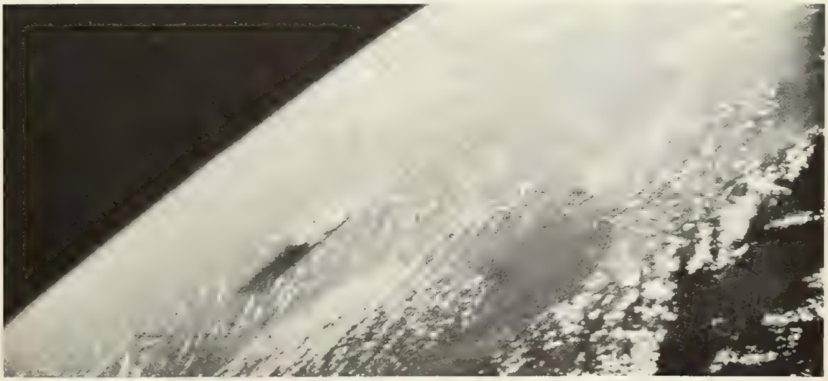
Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics|Astronautics, 5826 Kearny Villa Road, San Diego 12, Calif.





LUNAR LIFT OFF AT δ = −10° *Heading for an earth landing site latitude of +10°, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from γ= −6° to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

GD

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A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTISTS

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems...and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

INERTIAL GUIDANCE

BS degree in physics, EE or ME and 2 to 5 years of experience in one or more of the following:

TECHNICAL ANALYSIS: scope includes establishment of guidance and flight control system requirements, analysis of system performance, establishment of test parameters and initiation of design changes.

AUTOPILOT DESIGN: assist in the detail design and development of the Centaur space vehicle flight control system. The system includes the autopilot, programming devices, and passive tracking equipment. The designer is also responsible for design of necessary test equipment.

GUIDANCE SYSTEM: requires individual with design and fabrication experience for subcontractor control and to assure that the delivered guidance system is accurate and reliable. To achieve this goal, the tasks range from purest analytical study to configuration control.

DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability, or both.

Tasks involve TECHNIQUE DEVELOPMENT in the following:

SYSTEMS: User-Operations Analysis, Reliable System Design, System Reliability Models, Cost-Effectiveness Evaluation, Man-Machine System Analysis;

COMPONENTS: Reliable Hardware Design, Hardware Analytic Evaluation, Component Evaluation, Parts and Materials Selection, Specification Criteria, Supplier Programs and Evaluation.

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

EXPLORE THE IDEA of growth and advancement with one of the nation's prime aerospace firms, a company whose name is synonymous with leadership in a broad range of pace-setting industrial activities. Among dozens of active study contracts and in-process hardware projects which assure far-ranging challenges to Astronautics staff members are Nova, Centaur, Atlas SLV III, lunar vehicles, manned space stations, solar monitors and an impressive array of orbiting and space probe vehicles. Consider the scope of these projects. Match your interests and abilities with the activity descriptions at left. Visualize yourself at Astronautics, where the professional climate favors your career and the sunny San Diego climate favors your family's year-round enjoyment of life.

Explore the pleasures of San Diego living.

**If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5826 Kearny Villa Road, San Diego 12, California.*

Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, OPERATIONS AND SYSTEMS ANALYSIS, WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS AND CALIBRATION LABORATORIES, and TECHNICAL WRITING.

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GENERAL DYNAMICS | ASTRONAUTICS

ASTROLOG

Current status of U. S. missile and space programs

Missiles

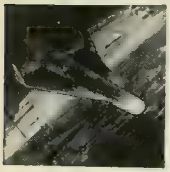
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; weight—500 lbs.; solid; HE depth charge; free-flight rocket; range 900 yds.	Operational; deployed on destroyers and cruisers
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid; nuclear or conventional warhead, range about 8 miles; weight: 1000 lbs.; unguided	Operational on DE, DD, DLG, & heavy cruisers. Advanced ASROC being developed; one "live" weapon fired in Pacific nuclear tests
ASTOR (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional; range, about 11 n. m.; solid	Development; to be deployed on hunter-killer submarines
ATLAS (Air Force)	STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series inertial guidance; ATLAS "D" radio inertial	13 squadrons operational at 11 bases; total no. of missiles: 129; phaseout to begin soon; ATLAS Standard Launch Vehicle being developed for AF space programs
★**BOMARC** IM-99A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000	Five bases operational in Northeastern U.S.; production completed; costs $20 million per year to operate system
BOMARC IM-99B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 n. m. range; nuclear	First base operational May, 1961; two more planned; production completed
★**BULLPUP** GAM-83A, ASM-N-7A (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol/Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and one pre-packaged liquid motor; nuclear-tipped	Deployed with Atlantic and Pacific Fleets; operational with Air Force units; new training version under development, as TGAM-83 replacement
CORPORAL (Army)	Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion	Surface-to-surface; 75 n. m. range; liquid; nuclear; pre-set & command guidance	Deployed in Europe. SERGEANT replacing CORPORAL
★**DAVY CROCKETT** M-388 (Army)	In-house project directed by Army Weapons Command at Rock Island, Ill.	Surface to surface; solid; bazooka-launched; sub-kiloton nuclear warhead; two launchers: vehicle-mounted or carried by two men	Operational in Europe; $13 million provided in FY '64 budget; 20 per division; seen as defensive rather than offensive weapon to prevent overrun of Europe
ENTAC (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; solid; shaped charge HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
★**FABMDS** (AADS-70) (Army)	GD/Pomona, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Field army ballistic missile defense system, mobile	Expected to be operational in 1970's
★**FALCON** GAR-1, 1D, 2, 2A, 2B, 3A, 4A, 9, 11 (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion; Lockheed Propulsion, GAR-9 propulsion	Air-to-air; 5 n. mi. range; supersonic; solid; conventional; 1, 1D and 3A, active radar homing guidance; 2, 2A, 2B and 4A, IR homing; GAR-11 model has nuclear warhead and hybrid IR radar homing	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under minimum effort development
★**GENIE** MB-1 (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 6-mile range; nuclear; solid rocket; supersonic; proximity fuzing	Operational on F-101B & F-106; improved version cancelled
★**HAWK** (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; 100-45,000 ft. ceiling; launch wt., 1275 lbs.; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); bought by Sweden and Israel; advanced HAWK being funded at $25.9 million for R&D as antimissile weapon

★ Indicates changes since March 1963 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN M-50 (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5900 lbs.; ADVANCED HONEST JOHN also being developed	Operational; deployed in Europe; to be replaced by LANCE
★**HOUND DOG** GAM-77 (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 2+; turbojet nuclear B version in production, ceiling in excess of 50,000 ft.	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400 to compensate for SKYBOLT cancellation
JUPITER SM-78 (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; range over 1500 mi.; guidance; all-inertial	Being withdrawn from operation; replaced by POLARIS; future of missiles being studied
LACROSSE (Army)	Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion	Surface-to-surface; mobile; command guidance; 20-mile range; solid; nuclear	Operational; three units in Europe; eight activated; to be replaced by LANCE
LANCE (Army) (Formerly designated MISSILE B)	Chance Vought Div., Ling-Temco-Vought, prime	A highly mobile general-purpose missile; range 3-30 miles; Automet guidance; one missile per launcher; nuclear and conventional warhead; pre-packaged storable propellants	Large-scale development; eventually will replace HONEST JOHN and LACROSSE; division support weapon; to use multi-system test equipment
★**LITTLE JOHN** (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable; may be replaced by LANCE
M72 (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; range 500 yd.; earlier called LAW	Operational
★**MACE** TM-76 A&B (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid; nuclear; B model: 1200-mile range; inertial guidance	Five MACE-A and one MACE-B squadron deployed in Europe; two MACE-B squadrons on Okinawa in hard sites
MATADOR TM-61C (Air Force)	Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft.	Being turned over to West Germans; also deployed in Korea and on Taiwan
★**MAULER** (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; deHavilland, IR acquisition; Raytheon, radar; Burroughs, computer; FMC, vehicle	Surface-to-air; IR acquisition; solid; weight, 120 lbs.; highly mobile antiaircraft and antimissile missile; tracked vehicle; 9 per launcher rack	Development; NATO may buy; Navy planning SEA MAULER; to use multi-system test equipment; FY '64 request is $83.3 million; usable against short-range tactical missiles
MOBILE MEDIUM-RANGE BALLISTIC MISSILE (Air Force)	Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos & Sperry Rand, re-entry system; Thiokol, propulsion; Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania, command and control; General Precision, guidance	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Continued development; no decision yet on production or deployment
★**MINUTEMAN** SM-80 (Air Force)	STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules third stage; Avco, re-entry vehicle	2nd-generation ICBM; solid; deployed in hardened and dispersed silos; 32 sec. reaction time; nuclear; 3 stages; range: over 5000 miles; guidance, all-inertial; target selected in seconds; advanced MINUTEMAN with greater range-payload and new re-entry vehicle under development	Development; 100 now operational at Malmstrom, Mont.; later at Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D., Grand Forks, N. D.; 950 missiles through FY '64; eventual force size may be 1300; advanced version to be fired from mobile command posts; expected operational 1965-66
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; ceiling, in excess of 150,000 ft.; solid; command guidance; Mach 3+; nuclear or conventional; antiaircraft, tactical missiles; weight, 10,000 lbs.	Over 80 batteries deployed in U.S.; over 10 N-H batteries deployed overseas. To be equipped with HIPAR, a high power acquisition radar, and anti-tactical-ballistic-missile capabilities
NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Antimissile missile; 3-stage; 200-mile range; solid; nuclear; command guidance; weight, 22,800 lbs.; length, 48 ft.; diameter, 36 in.; fin span, 10 ft.	Downgraded in favor of NIKE-X; continued development planned; funded for $89 million in FY '64; several successful intercepts
★**NIKE-X** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin-Marietta, SPRINT missile prime; Hercules Powder Co., SPRINT propulsion	Most advanced portion of NIKE-ZEUS concept; uses a mix of ZEUS/SPRINT missiles and ZEUS multi-function array radar (ZMAR)	Engineering development; funded for $246 million on accelerated development schedule, but deployment still deferred; more effective than NIKE-ZEUS
★**PERSHING** (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; inertial guidance; approx. 400 n. mile range; nuclear; transported on FMC XM474 tracked vehicle; to replace REDSTONE	Flight test program, including shots from Utah to New Mexico, nearly complete; first tactical equipment delivered to troops in Dec. '62; West Germany buying

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
PHOENIX (Navy)	Hughes Aircraft Co.	Air-to-air missile for use with the TFX fighter aircraft	Development; HAC has $12.2-million contract
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT/Hughes, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment: Vitro, systems engineering coordination and training	Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 aboard first five submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 6-17; A-3 (2500 n.-mi.) aboard 18th and subsequent subs; all subs to get A-3 eventually; Total authorized POLARIS submarine program: 41	Nine subs each with 16 missiles operational; A-2 operational; A-3 in 1964; 12 A-3 flight tests have been conducted; three fully successful; deployed in Atlantic and Mediterranean; Pacific servicing facilities being built; British to buy missiles from U.S.
QUAIL GAM-72 (Air Force)	McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Thompson Ramo Wooldridge, ECM equipment	ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
★**REDEYE** (Army)	GD/Pomona, prime; Philco, IR seeker; Atlantic Research, propulsion	Surface-to-air; 4-foot, 22-lb. bazooka-type; IR homing guidance; solid; conventional; length, 44 in.; diameter, 2.75 in.	Development; no procurement funds in FY '64 budget due to development problems resulting in two-year slippage
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; inertial guidance; nuclear	Deployed in Europe; being replaced by PERSHING
REGULUS I SSM-N-8 (Navy)	Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear	Deployed aboard 2 cruisers; phaseout of 5 Regulus subs to start this year; KDU-1: drone version; missiles retrofitted with airborne guidance
★**SERGEANT** (Army)	Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; over 75 n. mi. range; nuclear; inertial guidance uses drag brakes; 10,000 lbs.	Production; major procurement to be completed during FY '63; replacing CORPORAL; West Germany buying
★**SHILLELAGH** (Army)	Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic guidance	Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; testing at White Sands; to use multi-system test equipment; engineering development stage begins in FY '64; to be installed on Gen. Sheridan assault vehicle
★**SHRIKE** (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly ARM	Development; first production buy in FY '63; AF plans to buy it during FY '64
SIDEWINDER (GAR-8) (Navy-Air Force)	GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; 1-C models: switchable IR and radar-guided warheads; improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version started in 1962; NATO-built version now under test
SLAM (Air Force)	Ling-Temco-Vought, vehicles; Atomics International Div., NAA/Lawrence Radiation Labs, reactor; Marquardt, propulsion	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph	Propulsion system being developed under project PLUTO; feasibility proven by TORY reactor tests; DOD decision whether to continue program due this month
SPARROW III AAM-N-6A (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; production begun on advanced version (SPARROW III B) prime armament for F4H-1 and F3H-2 interceptor; SPARROW III and III A in use
★**SPRINT** (Army)	Martin-Orlando, prime; Hercules Powder, propulsion	High-acceleration missile for low-altitude interception of ballistic missiles; to be part of the missile mix in a NIKE-X battery	Development; studies submitted by Douglas' Martin and North American
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack subs of Thresher class; reportedly entire system was tested in recent nuclear tests
SS-10 (Army)	Nord Aviation, prime; GE, U. S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC
SS-11 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units and Army helicopters
TALOS (Navy)	Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance	Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance	Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, nuclear-powered cruiser, has advanced TALOS
TARTAR (Navy)	Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Ship-to-air; 10-mile range; Mach 2; beam-riding guidance; solid dual-thrust motor; conventional	Operational; installed aboard 15 guided missile destroyers and cruisers equipped with TALOS
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
TERRIER/ADVANCED TERRIER (Navy)	Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; ABL, propulsion	Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional; 2 advanced versions operational	Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**THOR** SM-75 (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle; Thiokol, solid rockets for added thrust	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear; guidance, all-inertial; used extensively as space booster	Phaseout; 15 missiles to be converted by Douglas for space boosters; some vehicles "souped up" by adding solid rockets for DISCOVERER program
TITAN (Air Force)	STL, systems engineering & technical direction; Martin, prime; Bell/Sperry, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	ICBM; 5000-mile range, LOX/RP-1 fueled; 90 ft. long; 2 stages	Operational; 54 missiles at 5 bases
★**TITAN II** (Air Force)	STL, system engineering and technical direction; Martin, prime; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle	ICBM; over 5000-mile range; N_2O_4 & Aerozine-50 storable fuels; 115 ft. long; 2 stages; greatest payload & range of any U.S. ICBM; basic core vehicle for TITAN III	Near operational; undergoing flight tests; some trouble experienced with second stage and with vibration; to be used with Gemini program as booster; overall performance high
TOW (Army)	Hughes, prime	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC
★**TYPHON** (Navy)	Bendix, GD/Pomona, missile and missile electronics; Westinghouse, weapons direction system and radar; McDonnell, propulsion	Medium and long range seagoing antiaircraft and antimissile missiles with offensive capability against surface ships and shore targets	Development; successor for TALOS, TARTAR and TERRIER. System is encountering development problems and deployment will await extensive testing
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	5-inch, air-to-surface; solid; unguided; 5 n.-mi. range; conventional	Operational; designed for use on jet fighter and attack aircraft



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ANNA** (NASA)	Bureau of Naval Weapons/Applied Physics Lab, prime; AF Cambridge Research Laboratories/Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter	Geodetic satellite; 600-mi. orbit; 36-in. aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by DELTA	Development; first launch failed May 10; second launch successful in November. Program now under NASA management. NASA to launch one satellite per year beginning in 1964
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; Grumman Lunar Excursion Module (LEM); MIT, guidance development; Collins Radio, telecommunications; Minneapolis-Honeywell, stabilization & control; AiResearch, environmental control; Radioplane, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN and SATURN C-1B for earth orbits; Advanced SATURN (C-5) for lunar rendezvous; 3-modular spacecraft: command module, 5 tons; service module, 23 tons; lunar excursion vehicle, 15 tons; total weight: 85,000 lbs.	Earth orbital shots scheduled 1964-65; lunar orbits 1967; lunar landing 1968
ARENTS (ARPA)	GD/Astronautics, prime	Series of three satellites to investigate space environment of 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload; program re-evaluated due to CENTAUR delay
AEROSPACE PLANE (AF-NASA)	No contracts announced	Manned, hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, LH_2-LOX rocket	Joint NASA-AF research program approved. NASA funding $4 million in FY '64
★**ASSET** (Air Force)	McDonnell Aircraft Corp., prime; Minneapolis-Honeywell, guidance	Aerothermodynamic/elastic Structural Systems Environmental Tests for various materials combinations during re-entry; two versions planned, 1100 lbs. (4) and 1200 lbs. (2). Strongly resembles X-20. Length: 68.7 in.; span: 58.9 in.	Development; six vehicles to be built & launched with THOR and THOR-DELTA boosters at AMR beginning this summer. Designed to obtain same general type of aerodynamic research information as X-20
BAMBI (ARPA)	Studies: GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost using space based platforms and interceptors	Feasibility still not proved; additional research under way
★**BIOS** (NASA)	GE, Lockheed, Northrop, study contracts	Recoverable capsules with primates aboard; capable of orbital flights up to two weeks; Flights to begin 1964	Program under study. Selection of prime expected by mid-year. NASA FY '64 budget request, $24 million
COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	Multiple-launch, active repeater ComSat; 24-36 satellites in 5000-12,000 naut. mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster	One of two systems resulting from reoriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966; RFPs due this month

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR (X-20)** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sunstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; future highly doubtful, with sharp cutback expected in wake of DOD/NASA agreement on AF use of GEMINI
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; January 1962 attempt failed to orbit; 1962 ballistic shot successful. ECHO II scheduled late 1963
GEMINI (NASA)	McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Westinghouse, rendezvous radar	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, 1963; manned and rendezvous flights, 1964-65; AF participation in program has been approved; this could add 4 to 6 more spacecraft to the program
INTERPLANETARY MONITORING PLATFORM (NASA)	Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit	125-lb. satellite launched into deep-space orbit with an apogee of 172,000 miles. It will measure radiation and solar flares in advance of Project APOLLO hazard. Launched by DELTA booster from AMR	Program calls for eight satellites. Launches will begin late 1963. Later flights will use a nuclear power unit as replacement for solar cells
★**LUNAR LOGISTICS VEHICLE** (NASA)	Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp.	Spacecraft to carry support payloads to the moon. Two designs under study, unmanned LEM vehicle and logistics spacecraft with 25,000 to 30,000 lb. payload	Program decision expected mid 1963; Cost expected to run to $500 million; contract expected in 1963
★**MANNED ORBITING SPACE STATION**	No contractors announced	Manned space station for testing components and techniques in the space environment. Design under study by NASA and AF	NASA and AF contending for program. Decision expected late 1963. NASA has requested bids on four study concepts. Small 4-6-man station will be built first. For flights in post-1966 period
★**MARINER** (NASA)	JPL, prime	450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by Aug. 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14; two Mars fly-by missions planned in 1964
MERCURY (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY will make one 34-hour flight
MIDAS, PROGRAM 239A (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; program being re-oriented from precise orbit satellite system to random orbit system due to technical difficulties with IR system; pushed back into development cycle
NIMBUS (NASA)	Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras	2nd-generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for late 1963; second, six months later; four R&D satellites, four Weather Bureau satellites planned
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3600-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, ATLAS-AGENA D	First flight scheduled in 1964; two more in 1965
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; nine other shots planned—five in '64 and four in '65

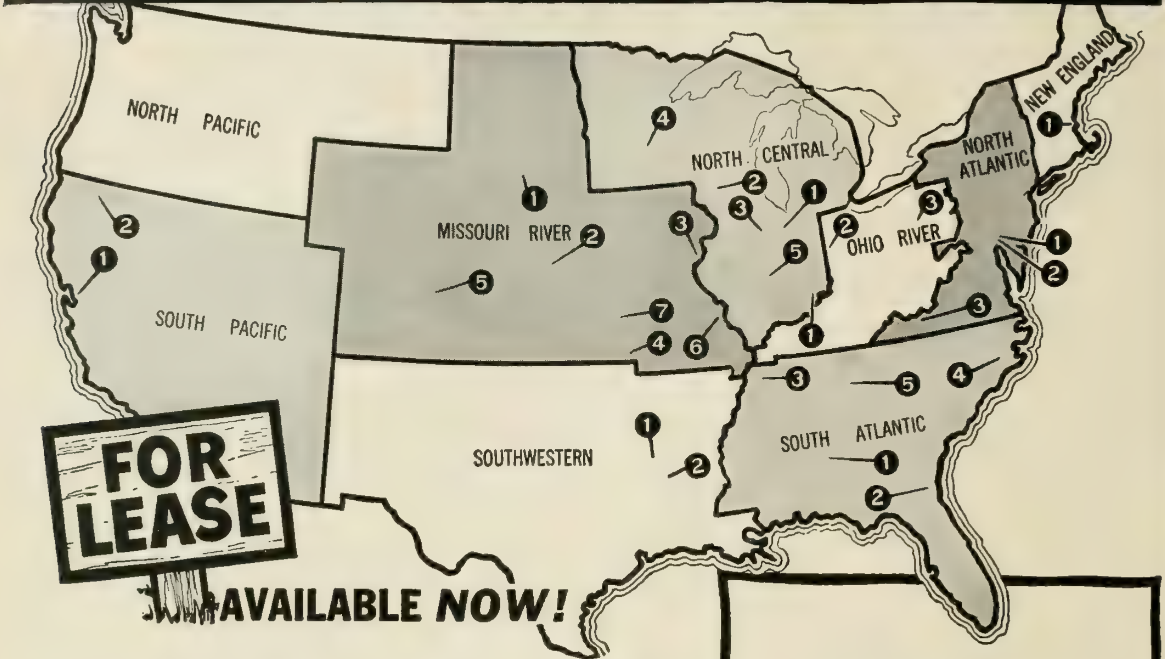
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; 10 more flights planned; advanced OSO studies by Ball Bros., Republic and STL
★**PIONEER** (NASA)	STL, Hughes competing for prime contract	120-lb. spin-stabilized solar probe; DELTA launch vehicle	Bids requested by Ames Research Center. Contract award imminent. Launches to begin in 1965
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket; Northrop, serving as support contractor, will be named prime in 1964	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D RANGER VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; plans call for a total of 22
REBOUND (NASA)	No contract announced	System of three rigidized multi-launched low-orbit passive communications satellites; ATLAS-AGENA booster	Under study
★**RELAY** (NASA)	STL, project coordination and systems planning; RCA, prime	150-lb., spin-stabilized, wide-band, 700-3000 mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II November, 1963
★**SATELLITE INSPECTOR (SAINT) PROGRAM 706** (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system also capable of destroying hostile vehicles	R&D; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, based on a manned system using GEMINI capsule
★**SAMOS** (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300 mile circular polar orbit	Development; was scheduled to be operational 1962; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched in 1963 with Hughes and Lewis Center engines
SLOMAR (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Orbiting Development Station
★**SURVEYOR** (NASA)	Hughes, prime; Martin, SNAP device	2100-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights early 1965; seven soft-landing vehicles planned; five lunar orbiters also scheduled
★**SYNCOM** (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55-lbs.; capable of accommodating one full duplex radio telephone channel	First launch failed, Feb. 14, 1963 satellite believed to be in orbit but contact lost. Second launch planned mid-1963. 500-lb. advanced SYNCOM to be developed
★**SMS** (Synchronous Meteorological Satellite) (NASA)	Republic, RCA, Hughes, study contracts	24-hour weather satellite, earth stabilized; TV cameras with variable focus; may use Snap-50 for power; Booster may be ATLAS-AGENA or CENTAUR	First flight 1966; No development funding in Fiscal '64 budget
TELSTAR (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10 highly successful; second launch scheduled May, 1963
TIROS (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3,000 mi. apogee)	R&D; Six satellites launched; all successful. Seven more added to program (4 R&D NASA, 3 operational, Weather Bureau)
TRANSIT (Navy)	Applied Physics Laboratory, prime; Martin SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; TRANSIT 5-A failed after achieving orbit in December
VELA-HOTEL (ARPA)	STL, prime; Los Alamos Scientific Lab/Aerospace, payload	12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; three satellites placed in one orbital plane with three more in a plane 90° to the first; booster, ATLAS-AGENA	Initial launchings expected during this calendar year
★**VOYAGER** (NASA)	Study contracts, Avco Corp. & GE	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface	Funds may be in FY '65 budget. Launches in 1968-70 period. Spacecraft weighing 6,000 lbs. would be launched by ADVANCED SATURN

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000 mph flight at edge of space; each rocket engine develops 57,000 lbs. thrust; reentry high angle of attack fights providing data for X-20	Powered flights in progress; unofficial records set: altitude (314,750 ft) and speed (4104 mph); X-15 will be used as trainer for X-20

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-pound upper stage; all-inertial guidance; re-start capability	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
CENTAUR (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date; next launch mid 1963
DELTA (NASA)	Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 430 lb. payload capability in 500 mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively; THOR missile comprises first stage	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational early 1963
LITTLE JOE II (NASA)	General Dynamics/Convair, prime	Solid propelled vehicle with thrust of 800,000 lbs.; Launch vehicle for APOLLO suborbital flights	First launch scheduled mid-1963; Four vehicles ordered thus far
NOVA (NASA)	General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study. Further studies to be awarded	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st stage thrust or use of nuclear upper stage)	Study to determine characteristics; operational target date post-1970 time period
★**ORION** (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift over 1000 tons into orbit	Studies; feasibility proven; AF FY '64 request for $9.8 million denied by DOD; R&D continuing with AF funds re-programmed from FY '63
★**ROVER** (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: KIWI tests, prototype of NERVA engine, under way	First ROVER flight test expected before end of decade
★**SATURN I** (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 22,000 lbs. into 345-mi. orbit	Four flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages July-August, 1963
SATURN I-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 32,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; may also be used as a supply vehicle
SATURN V (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-1B: 5 F-1 engines; S-11: 5 J-2 engines; S-IVB: J-2 engine; 120-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1965; prime booster for APOLLO missions; will also be used to boost Orbiting Space Station
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 250 lbs.
TITAN III (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight late '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 5 TITAN II core vehicles (A version), 12 full TITAN III's (C version); operational in 1965

PROPOSALS SOLICITED FOR LEASE OF DEPARTMENT OF THE ARMY FACILITIES



All or portions of these facilities are available for either commercial or industrial applications, dependent upon the requirements of the lessee. Possible uses are unlimited.

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Detailed information, arrangements for inspections, invitations for proposals and sample form of lease may be obtained from the U.S. Army Division Engineer having jurisdiction over the area in which you are interested. The addresses of the Divisions Engineers are:

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2. Cornhusker Ordnance Plant, Grand Island, Nebr.
3. Iowa Ordnance Plant, Burlington, Iowa
4. Kansas Ordnance Plant, Parsons, Kansas
5. Rocky Mountain Arsenal, Denver, Colo.
6. St. Louis Ordnance Plant, St. Louis, Mo.
7. Sunflower Ordnance Works, Lawrence, Kansas

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2. Fort Meade, Odenton, Md.
3. Radford Ordnance Plant, Radford, Va.

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3. Joliet Arsenal, Joliet, Ill.
4. Twin Cities Ordnance Plant, Minneapolis, Minn.
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U.S. 'Traffic' To Top 200 by 1976

NASA projection is that manned flights will account for 50% of total; transport vehicle concepts described

DALLAS—U.S. space traffic is expected to rise from a total of 70 attempts this year to about 85 in 1966 and then should drop to a low of less than 50 in 1969.

This projection was worked out by H. H. Koelle, director of future projects for NASA's Marshal Space Flight Center. A chart presented by Koelle (see below) shows traffic leveling off at a peak of well over 200 in 1976. Until 1972, manned space flights make up a very small part of the total, but by 1976 they are to account for about half of the traffic.

Concepts of vehicles to supply this transportation need were discussed by L. T. Spears and C. H. Rutland of the MSFC future projects office at the Second Annual Manned Space Flight Conference sponsored here by NASA and the American Institute of Aeronautics and Astronautics.

After the initial placement of men and equipment in orbit and on the Moon, resupply and crew rotation will provide the transportation demand. Designers can expect some freedom in selecting the payload weight for cargo vehicles and would normally tend to choose a large vehicle for lower trip frequency. However, personnel requirements will create a demand that is somewhat independent of vehicle size because of crew rotation at staggered intervals and unpredicted needs.

- **Space omnibus**—Since space exploration on a large scale is likely to be conducted with the aid of persons other than broadly qualified astronauts, the hypothesized transportation spacecraft have been designed to accommodate people of varied age and physical condition. This includes limiting accelerations to 3g or less in normal operation and to 4g for an abort. Horizontal takeoff appears to be a good way to meet this requirement, and results in satisfactory performance using one possible approach to the initial boost problem.

The size of HTO space transports using conventional airfields is set by runway weight limitations. A proposed way of alleviating these limits is to use a rocket sled on tracks for initial acceleration and to leave much of the propulsion weight and undercarriage on the sled when the transport lifts off.

By this method the HTO vehicle can be made competitive in performance with vertical rising rockets of the type now common. It may even be able to exceed the performance of rockets using the conventional vertical launch technique.

The number of stages that must be recovered and prepared for flight can be minimized by putting the passenger accommodations in a reusable second stage. An interim type with a separate payload and an expendable second stage might be useful before complete reusability can be attained.

The sled could be propelled by the main boost engines with tanks on the sled replenishing the expended propellants. Thus, the main propulsion would be operating from the beginning of the take-off run and there would be time to refuse the take-off if a malfunction were detected.

Another approach, not as thoroughly studied, would be a "linear steam turbine" with the turbine blades along the track. More impulse could be obtained from such a catapult than by exhausting the steam through rocket nozzles.

- **Water braking**—In both cases, the sled—or in the case of a refused take-off, the sled and the vehicle—would be decelerated by a water brake. After a successful launch and separation, the first stage would turn around a few hundred miles downrange and fly back to a landing area near the launch site under the power of subsonic turbojet engines.

After off-loading passengers at an orbiting space station and perhaps picking up a return load, the passenger vehicle would re-enter by a retro-thrust maneuver and then operate as a glider unless go-around capability is needed.

- **Combination sought**—There are indications that some combination of rocket and air-breathing propulsion would be better for the Earth-to-orbit transport than either type alone. Air augmentation of rocket thrust accomplished by ingesting air through an annulus around the rocket engine to be heated and accelerated by the rocket exhaust is being investigated. Rocketdyne F-1 and J-2 engines are being studied for use in such an arrangement.

For transportation to the Moon, the future projects office is discussing connecting flights from Earth to orbit, orbit to lunar orbit, and lunar orbit to the surface of the Moon. Nuclear propulsion is favored for the orbit-to-orbit journey. ■

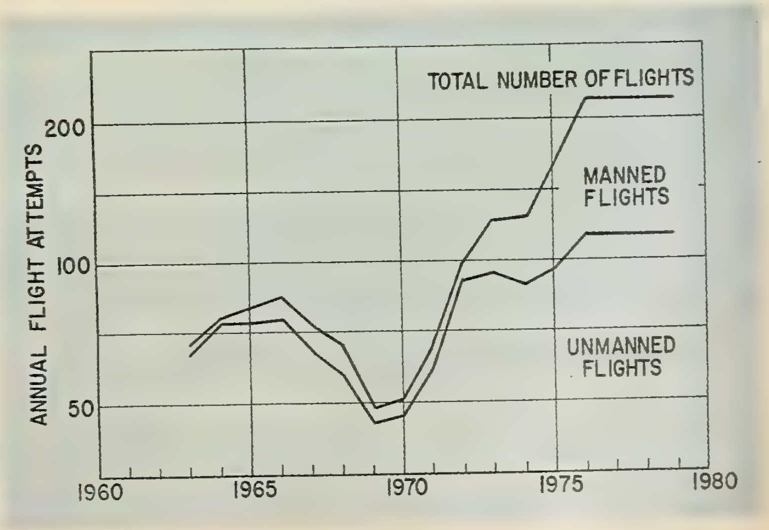
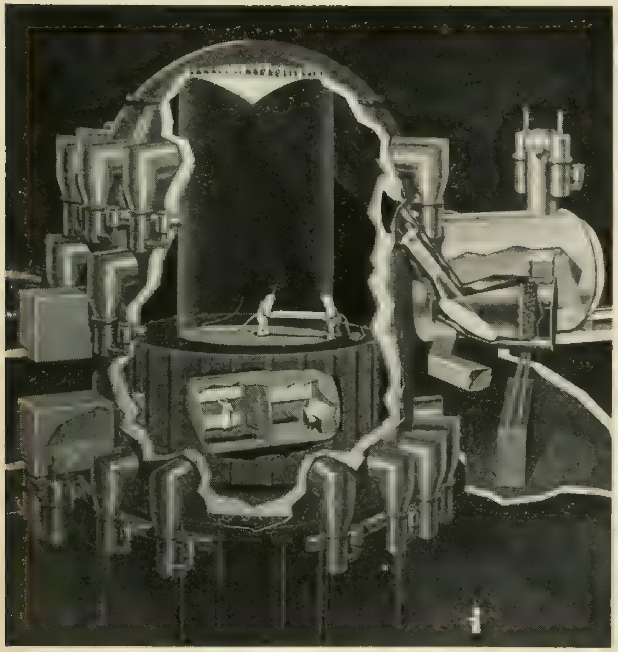
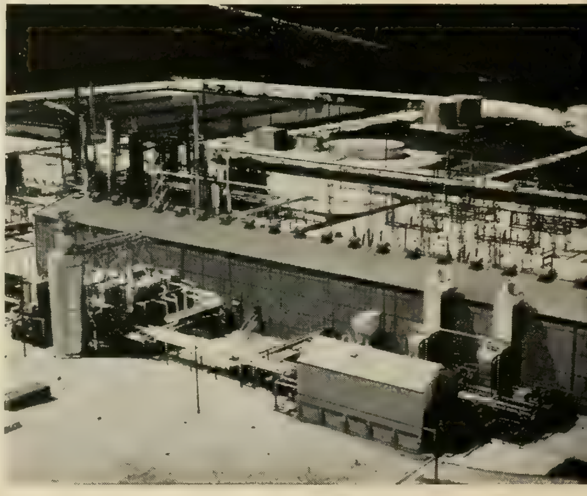


CHART SHOWS official space agency estimate of U.S. space traffic through 1976.

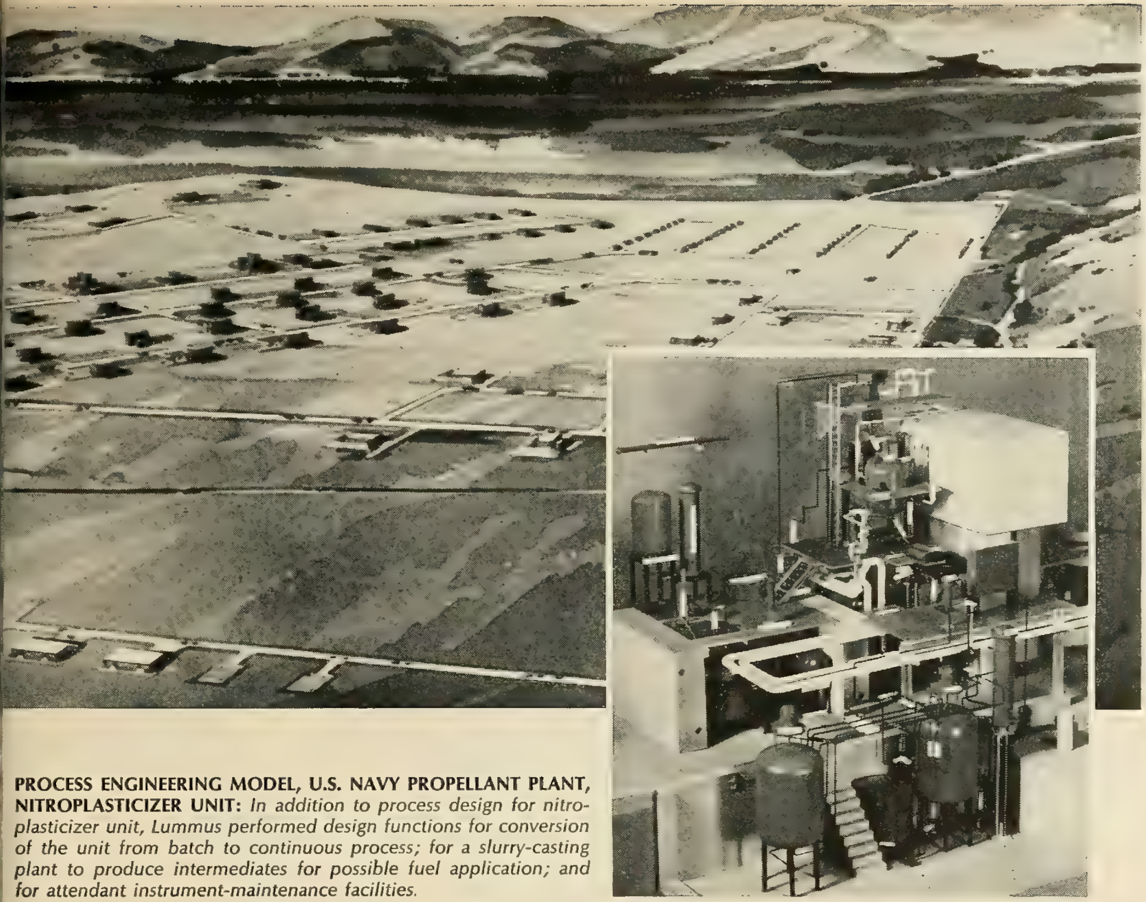
SOLID PROPELLANT PRODUCTION FACILITY—U.S. AIR FORCE PLANT #78: *Lummus' architect/engineering design for this propellant complex included auxiliary facilities for MINUTEMAN horizontal engine testing, propellant handling and storage considerations, and rocket-engine handling.*



LUNAR ENVIRONMENTAL RESEARCH FACILITY—U.S. ARMY CORPS OF ENGINEERS: *Lummus performed the conceptual engineering for this simulator which established the engineering feasibility to provide for vacuums up to 1×10^{-8} torr, temperatures as low as −423°F, and solar radiation twice the intensity of the noonday sun—up to 130 watts/sq. ft.*



WORLD'S LARGEST LIQUID HYDROGEN PRODUCTION FACILITY—U.S. AIR FORCE PLANT #74: *Lummus designed, engineered, and constructed the hydrogen-production process phases of this plant to produce 99+% pure hydrogen, which is then liquefied through cryogenic processes.*



PROCESS ENGINEERING MODEL, U.S. NAVY PROPELLANT PLANT, NITROPLASTICIZER UNIT: *In addition to process design for nitroplasticizer unit, Lummus performed design functions for conversion of the unit from batch to continuous process; for a slurry-casting plant to produce intermediates for possible fuel application; and for attendant instrument-maintenance facilities.*

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Mergers and Acquisitions

Simpson Instruments, Inc., Pasadena, Calif, has purchased the electric meter operations of Beckman Instrument Inc.'s Helipot Div. at Escondido, Calif. Transaction included complete lines of Beckman/Helipot precision panel meters and expanded scale meters used in instruments and control and power monitoring systems. . . . *Control Data Corp., Minneapolis, has entered into agreement to acquire the business assets of Beck's, Inc., St. Paul electronics firm. Beck's has been developing, manufacturing, and selling printed circuit boards for use in computers and other electronic equipment. Sale remains subject to Beck's stockholder approval.* . . . General Telephone and Electronics Corp., New York City, has filed application with the Federal Communications Commission to purchase stock in the Communications Satellite Corp. as a communications common carrier. CSC was created through the Communications Satellite Act of 1962 to establish a commercial space communications system. Under the Act, the FCC is provided with regulatory powers over various aspects of the corporation's operations. . . . *Hughes Dynamics, Inc., new subsidiary of Hughes Tool Co., has acquired a 10-year option to purchase the majority of the stock of Dashew Business Machines, Inc. Deal includes a management contract under which HDI will operate Dashew. HDI has also purchased Advanced Information Systems, Inc., Los Angeles subsidiary of Electrada Corp.* . . . Allied Research, Inc., and Baird-Atomic, Inc., both of Cambridge, Mass., have called off a proposed merger. Baird-Atomic develops instruments for analysis and control satellites; ARA is an electronics firm.

New Firms and Divisions

Computer Control Co., Inc., has opened a Houston district office to serve Texas, Oklahoma, Arkansas, and Louisiana. Located at 3303 Montrose Blvd., the new office will be responsible for applications engineering of 3C products. . . . *The Walworth Co., Oakland, Calif., industrial valve producer, has established a sales group, called the Aerospace Div., in Los Angeles. Field personnel from the office will market valves and regulators for missile/space use in the Southwest and Southeast. Division address will be 650 N. Sepulveda Blvd.* . . . The General Electric Co. has established a new laboratory for expanding the applications of magnetohydrodynamic (MHD) power generation to space vehicles at its Valley Forge, Pa., Space Technology Center. The lab will be used primarily to research, develop and test MHD generators for use with nuclear reactors in a closed cycle. Research emphasis is to be on increasing power output. GE has also formed a new Vacuum Products operation in Schenectady, N.Y., to develop, manufacture and market ultra-high vacuum equipment for space research, electronic and industrial use . . . . *Philco Corp. has established a marketing office at 103 E. Front St., Red Bank, N.J., to provide industrial sales and service in the area.* . . . Microwave Associates, Inc., Burlington, Mass., has formed a wholly owned subsidiary, Microwave Assoc. International, Inc. The new international subsidiary aims at expanding the company's activities in the world market. . . . *JFD Electronics Corp. (Brooklyn, N.Y. and Oxford, N.C.) Components Div. has formed JFD Mid-Atlantic to serve southern New Jersey, greater Philadelphia, Delaware, Maryland (excepting Allegany, Garrett, and Washington counties), Washington, D.C., and Virginia. Headquarters are in Palmyra, N.J.*

Representatives Named

Norvell Associates, Inc., Houston and Dallas, has been named Texas-Oklahoma-Louisiana-Arkansas representative for Vitramon, Inc., effective May 1. Vitramon, Bridgeport, Conn., manufactures solid-state procelain and microminiature ceramic capacitors. . . . *Airsupply-Aero Engineering Div. of Garrett Corp., Beverly Hills, Calif., has been named eastern-U.S. engineering/sales representative for Hydraulic Research and Manufacturing Co. of Burbank. Contract covers types of fluid power control systems and equipment, such as missile steering control.*

Potpourri

A synchronized team of five RCA computers has been assigned the job of cataloging on a continuously updated basis more than 674,000 industrial supply items for the Defense Industrial Supply Center in Philadelphia. The effort is said to make possible a $3-million annual savings in processing costs. DISC is a major division of the Defense Industrial Supply Agency, which was established in 1961 to service all branches of the U.S. armed forces on a centralized basis. In addition to producing catalogs, the DISC data center serves as a world-wide data-control center. Using the RCA data processing complex, DISC can maintain requirements of operating units and mobilization reserve items at a desired level, taking into account the necessary "lead time" for emergency reordering. . . . *In the last six months of 1962, The Bendix Corp. reports it placed $56,931,000 in orders with small business concerns. Expenditures in New Jersey, where the engineering and production operations in space and missile guidance and flight control systems for three divisions are centered, was $19,810. Small businesses in Indiana, where the company is prime contractor for the Navy's Talos and Typhon missiles and has its Aerospace div., received $12,888,000. Other states where subcontractors received large Bendix expenditures were New York, $8,315,000; Maryland, $5,703,000; California, $4,480,000; and Michigan, $3,000,000.*

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—contracts and procurements—

AWARDS

AIR FORCE

$11,400,000—**Hughes Aircraft Corp.**, Tucson, Ariz., for *Falcon* air-to-air missiles.

$9,500,000—**General Precision, Inc.**, Little Falls, N.J., for continued research, development and engineering on the dual stellar inertial guidance system envisioned for the *MMRBM* (2 contracts).

$7,700,000—**Hercules Powder Co.**, Bacchus, Utah, for continued production of third stage *Minuteman* motors.

$2,900,000—**Garrett Corp.**, Phoenix, Ariz., for work on a nuclear power unit.

$2,300,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for continued work on a control network for satellites.

$1,500,000—**North American Aviation, Inc., Space and Information Systems Div.**, Downey, Calif., for spare parts for *Hound Dog* missile.

$1,400,000—**Avco Corp.**, Wilmington, Mass., for work on a classified project.

$1,200,000—**General Electric Co.**, Syracuse, N.Y., for Atlantic Missile Range testing operations.

$1,100,000—**International Telephone and Telegraph Corp.**, New York City, for space communications modifications at Vandenberg Air Force Base, Calif.

$1,100,000—**Lockheed Aircraft Corp., Missiles and Space Co.**, Sunnyvale, Calif., for continued work on space subsystems.

$1,100,000—**Jen-Mar Construction Co.**, San Diego, Calif., for support facilities for *Minuteman* weapon system at Warren Air Force Base, Wyo.

$1,000,000—**Radio Corp. of America**, Burlington, Mass., for research on components for space application.

$1,000,000—**Avco Corp.**, Wilmington, Mass., for continued research and development on re-entry vehicles.

$1,000,000—**Minneapolis-Honeywell Regulator Co.**, Minneapolis, for continued research, development, technology and engineering on primary guidance system for the X-20 (*Dyna-Soar*). Work to be done at St. Petersburg, Fla.

$450,000—**Antenna Systems, Inc., Electronic Systems Div.**, Maitland, Fla., for the design, fabrication, installation, test and checkout of equipment for updating three 60-ft. automatic tracking telemetry antennas located at Cape Canaveral and on the Atlantic Missile Range.

ARMY

$1,800,000—**Sperry Rand Corp.**, Great Neck, N. Y., for engineering services on the *Sergeant* missile system at the Redstone Arsenal, Huntsville, Ala.

$1,700,000—**Joy Manufacturing Co.**, Michigan City, Ind., for production of air compressors.

$1,200,000—**General Dynamics Corp., Pomona Div.**, Pomona, Calif., for continued research and development on *Redeye* missile.

$1,080,000—**Hayes International Corp.**, Birmingham, Ala., for manufacture of modification kits for *Pershing* missile trainers.

$260,000—**Sperry Rand Corp., Sperry Utah Div.**, Salt Lake City, for *Sergeant* missile parts and equipment and ground support (4 contracts).

$99,000—**Radio Corp. of America**, Camden, N. J., for research leading to development of a thermoelectric power module of advanced design.

$43,400—**Magnavox Co.**, Urbana, Ill., for design and development of fuze warhead for the *Redeye* missile.

Curtiss-Wright Corp., Wood-Ridge, N. J. for production of reinforced plastic rocket nozzles for *Pershing* missiles (multi-million dollar contract).

NAVY

$13,245,000—**Sperry Gyroscope Co.**, Great Neck, N. Y., for *Polaris* missile system management and field engineering for navigation subsystem.

$3,900,000—**Garrett Corp.**, Phoenix, Ariz., for gas turbine compressor power units, ground servicing units and installation kits.

$3,587,324—**General Precision, Inc.**, Glendale, Calif., for ASROC fire-control systems and related equipment.

$2,285,983—**Edo Corp.**, College Point, N. Y., for long range detection and tracking sonar sets with hydrophones and related material and services.

NASA

$9,500,000—**General Precision, Inc., Link Div.**, Binghamton, N. Y. for development and installation of *Apollo* mission simulators at the Manned Spacecraft Center, Houston, and at the Atlantic Missile Range, Cape Canaveral.

$5,800,000—**Catalytic Construction Co.**, Philadelphia, for synchrocyclotron and associated equipment to be installed at the Langley Research Center, Va.

$1,234,761—**Chrysler Corp.**, Michoud, La., operations, for modifications to *Saturn* booster production facilities.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Automatic narrow bank power spectrum analyzer. RFP A-7105. RFP due date 5-23-63. Copies of IFB and RFP will be furnished to the extent available on a first received first served basis.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Tex.

Solid propellant landing rocket motor. Delivery to NASA CMM Manned Spacecraft Center, Houston, Tex. Item RFP MSC 63-540P. RFP due date 5-17-63. Contact contract negotiator, W. Vander Voort, WA-2811, Ext. 7211.

Procurement and Production
Base Procurement Div.
L. G. Hanscom Field
Bedford, Mass.

Trailblazer II research sounding rocket system. Svg. drawing D3131 and field launch services applicable thereto—3 each. PR Req. No. CRL-0075. Single source to be negotiated with Space Vehicles Div., Atlantic Research Corp., El Monte, Calif. Note: For information only, no RFQ available.

Rocket motor with igniter, model XM 3348, Castor—3 each. RFP CRL-0074A. Single source, to be negotiated with Thiokol Chemical Corp., Alpha Div., Huntsville, Ala. Note: For information only, no RFQ available.

Rocket motor, Model XM19E1, "Recruit"—6 each. P. R. No. CRL-0072. Single source, to be negotiated with Thiokol Chemical Corp., Elkton Div., Elkton, Md. Note: For information only, RFQ unavailable.

Rocket motor with nozzle and blowout diaphragm, Cygnus 15—3 each. P. R. No. CRL-0073. Single source, to be negotiated with Aerojet-General Corp., Sacramento, Calif. Note: For information only, RFQ unavailable.

Missile and Propulsion Branch
Titan Procurement Div.
Directorate of Procurement and Production
Norton Air Force Base, Calif.

PL 04-607-63-22 against existing contract AF04 (607)-7652 with Martin Marietta Corp., Denver 1, Colo., is in process. This procurement is for services to repair *Titan I* launcher system simulator. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firm.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Ames Research Center has selected the General Electric Co., Re-Entry Systems Dept., Philadelphia, Pa.; Lockheed Missiles and Space Co., Sunnyvale, Calif., and the Northrop Corp., Northrop Space Laboratories, Hawthorne, Calif., for negotiations leading to contract award of a study to define the engineering aspects required to implement the biosatellite program. The biosatellite program is approximately a three and one-half year program consisting of approximately six flights in a circular orbit approximately 200 miles high carrying biological experiments including live animals. Spacecraft are to be recoverable with orbit times of three to 30 days. First flight expected within 17 months after award of a follow-on fabrication contract. Primary emphasis in the study is placed on the spacecraft and its systems, but all aspects of the project shall be considered including selection of a launch site, launch vehicle communications facilities, recovery operations and recovery site. Selection of experiments will not be included. RFP A-6824. Phase II due date approximately 6-13-63. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firms.

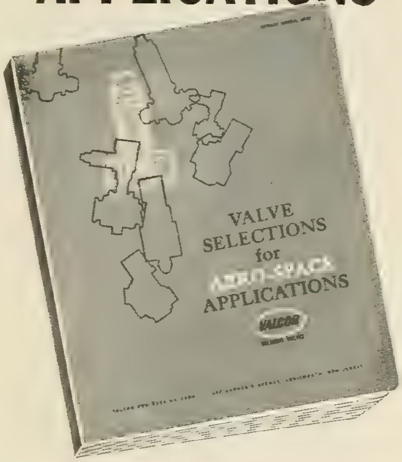
Hawk Project Manager's Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Motor metal parts, SM22E8, for *Hawk* missile system. 2091 sets with optional quantity of 44 sets. Delivers to Sacramento, Calif. RFQ AMC(Z)-01-021-HAP-64-1 Q; RFQ due date 7-8-63 is due date for quotations in respective procurement districts. The production of the supplies listed requires a substantial initial investment and an extended period of preparation for manufacture. This item has inherent fabrication difficulties and complex manufacturing processes which are critical. Prospective offerors may contact the appropriate procurement district for copies of RFQ specs. Requests for above documentation should be made by 5-10-63 to enable the procurement district to mail the RFQ directly to prospective offerors at time of issuance. This action is for planning purposes only and does not constitute a formal request for quantation. The procurement contemplated is included and provided for in the operating budget for FY '64.

Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

High performance *Apollo* propulsion system study which includes propellant survey and selection, vehicle design, reliability analysis, and development effort. Job—RFP MSC-63-589P. RFP due date 5-23-63. Deadline date for issuing RFP 5-14-63, unless supply exhausted earlier.

VALVE SELECTIONS FOR AERO-SPACE APPLICATIONS



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Circle No. 9 on Subscriber Service Card

Microminiature T/M System Evolving

SOUTHAMPTON, PA.—A significant advance in development of microminiaturized telemetry system components is reported by engineers at Vector Manufacturing Co. here.

Using a hybrid thin-film integrated circuit, Vector has deposited what amounts to an entire voltage-controlled subcarrier oscillator t/m subsystem on a single passive substrate. The entire aluminum-cased module weighs 2.5 grams, occupies less than 0.73 cu. in., and draws only 3ma from an unregulated (±10%) 28-vdc source.

Vector reports it approached the VCO problem first, because it represented both the largest single building block in a t/m system and the most difficult portion of a system to substantially reduce in size—the latter being due to strict analog circuit tolerances. Techniques applied in the VCO project already have been used, say Vector engineers, to develop a mixer-amplifier. They add that they are moving towards new commutators and analog-to-digital converters in an effort to come up with a completely microminiaturized t/m system.

Using a variety of circuit deposition techniques, Vector designed the module so that all elements which control the frequency of the unit—the voltage regulator, temperature-compensated d-c amplifier, and a free-running multivibrator—are all on the same side (and thermal level) of the alumina substrate. Packaged on the other side is the active linear-phase-output filter element. Internal connections are made by thermal compression bonding.

- **Size, weight cut**—Vector reports that the MMO-10-VCO is smaller and lighter by a factor of 20 than the next smallest miniaturized device the firm manufactures, the TS-54 CVO now in service aboard the *OSO* satellite and in several missile programs. Power requirements are down by a factor of five for the same operating parameters.

Four of these devices have been sold to the Navy's Aeromedical Acceleration Laboratory in Johnsville, Pa., where they are reported to be working well in a biomedical telepack research project. Vector engineers stress that size, weight, and power reductions which contribute to increased payload and reduced shock acceleration should make the unit applicable to space vehicles, lunar-rover types of vehicles, and some tactical missiles.

Vector reports that these devices, which operate over all IRIG channels from 400 cps to 70kc, have an input impedance of 1 megohm ±20%. Drift is reported to be less than 1% of design bandwidth (dbw) for a period of 8 hours at ambient temperatures following a 3-min. warm-up, and less than 0.25% after a 15 min. warm-up.

The output frequency of the MMO-10 is said to be stable to within ±3% of dbw for a temperature change of 0°C. to +80°C., and to within ±5% of dbw with the range increased to −20°C. (Vector says this latter figure can be reduced to ±1% for individual units). Total operating range of the VCO is from −55°C. to +125°C. Within the −20°C. to +80°C. range, the company reports, a 10% change in the supply voltage will vary the center frequency less than ±0.5%.

Vector engineers claim that several factors, some purely technical and others conceptual, contributed to the repeatable stability of these units. The key, they say, was in-house development of all the VCO components.

- **New lab opened**—Vector put a microminiaturization lab into operation about three years ago, and a new 15,000-sq.-ft. lab was put into service last week.

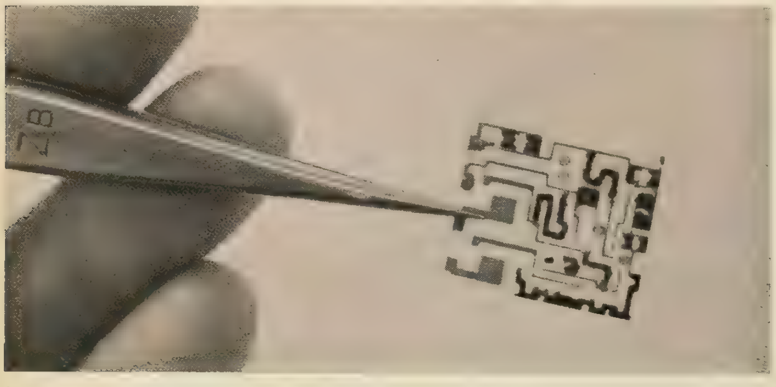
Two new components, a sensistor and a capacitor, developed in-house are of particular interest.

The capacitor is reported to have a temperature stability approaching 50 parts per million per degree C. and a capacitance range from 30-3,000 micro-micro farads. Breakdown voltages exceeding 200 volts are claimed. The thermally grown dielectric is applied in 2,000-15,000 Ang. thicknesses, and the overall size of the capacitor ranges between 25-200/1000 sq. in.

The sensistor, Vector engineers say, is a thermally variable resistance made from an intrinsic semiconductor with diffused impurities with a concentration of less than 50 parts per million. Sensistor size is listed as 5-20/1,000 in. wide × 50-75/1,000 in. long × 3-5/1,000 in. thick, with resistance values available between 100-50,000 ohms.

The stability of the new VCO, according to Vector, has also obviated the need for adjustment potentiometers in the design. Furthermore, the units are aged under power as complete VCO's, rather than as discrete components, in a +200°C. environment for 24 hrs. both before and after encapsulation (prior to mounting in the aluminum can the units are given a hermetic varnish-type encapsulation).

Vector also designed a new VCO connector, to which between 1 and 18 of these units can attach in any type of data link. This doubles as the vehicle mount, further reducing overall hardware needs. ■

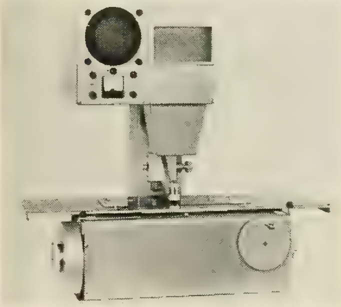


TYPICAL IN-PROCESS substrate used by Vector in the MMO-10 device. All elements that control frequency of the VCO are packaged on one side of the alumina substrate, with the active filter element on the other side.

New Product of the Week: Line-Measuring Comparator

Grant Instruments is marketing a spectrum line-measuring comparator engineered to repeat measurements over a 10-in. distance to within ±0.50 microns. The unit will accept line widths from five microns to one millimeter. The comparator projects two oscilloscope traces, which, when matched, align the workpiece with the instrument's optical axis.

In operation, images of the line being measured are formed in three places: (1) on a 4″ × 7″ viewing screen, (2) on a photomultiplier whose output goes to the vertical deflection of the built-in oscilloscope where the line profile is viewed, (3) on a photometer that registers the light transmission or reflection of the workpiece. Light-admittance slits in front of each photomultiplier are adjustable up to 20 mm. in width.



As the carriage is advanced and a line comes into view, two traces of the line appear on the oscilloscope screen, travelling toward each other. When the line is exactly centered in the optical system, the two oscilloscope traces coincide, providing an accurate setting on the line.

Circle No. 228 on Subscriber Service Card

Aerosol Photometer

Royco Instruments, Inc., has available Model 230 Aerosol Photometer that measures and indicates total average logarithm of light scattered by large number of particles in sample stream. It is said to provide a reading of relative aerosol concentration in monodisperse aerosols or in aerosols having constant spectra of sizes present.

Functionally, the unit contains an airflow system that pumps a continuous sample of specimen air through an optical sensor comprising a light-scattering system that measures the luminous intensity in the moving air stream.

Circle No. 225 on Subscriber Service Card

Brush Block Assembly

J. M. Ney Co. is marketing a standard molded brush block assembly for card and tape sensing applications requiring a number of inline contacts within a given space. It is also used as a brush assembly for slip-rings and commutators.

The assembly is available with various numbers of contacts in any center spacing from 0.1 in. up. The contact tip can be either a straight or a formed wire of 0.030-in. outside radius, and is available with up to 20 stations, each containing three strands of 0.010-in.-dia. Paliney 7 heat-treated wires.

Circle No. 226 on Subscriber Service Card

Two-Axis Free Gyro

PneumoDynamics Corp. Instrumentation & Control Div. has announced a line of two-axis free gyros that provide displacement sensing of vehicle motion for a wide range of applications.

The Series CFG can sense pitch, roll or yaw in any combination of two axes, or, by the elimination of a pickoff on the inner axis, can serve as a single-axis displacement sensor. Gimbal freedom for this line is ±85° on the inner axis and 360 degrees on the outer axis.

Series CFG gyro rotors operate from 115- or 26-volt single or three phase, 400-cycle power.

Circle No. 227 on Subscriber Service Card

Hot Plate Apparatus

A guarded hot plate apparatus, capable of measuring thermal conductivity over a temperature range of 75°-800°F, has been developed by Dynatech Corp.

Designated Model TC-2000, the device includes a precision potentiometer, a voltage-regulated power supply, and a solid-state proportional controller.

Power requirements are 110v a-c, 2.5 kw maximum. A calibrated wattmeter with ¼% accuracy is supplied for power measurements. Control is automatic with an accuracy of ±2%, and maximum heat flux is 10,000 BTU/hr-ft^2.

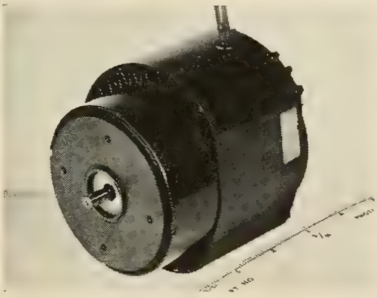
Optional equipment includes a custom environmental system (inert gas or 10 micron vacuum) or a vacuum system capable of providing an environment of 10^{-4} mm Hg.

Circle No. 229 on Subscriber Service Card

A-C Motor

A type of dual-speed a-c motor for computer tape transport use has been developed by the Westinghouse Aerospace Electrical Div.

The motor operates on a three-phase, 400-cps, 208-volt power supply.



It has two windings; one is two-pole, the other, 16-pole. The two windings are said to provide nominal operating speeds of 23,500 rpm and 2850 rpm.

Circle No. 230 on Subscriber Service Card

Superconducting Energizer

Avco Research Laboratory is said to have developed a method to energize superconducting magnets by trapping small packets of magnetic field lines and feeding them into the magnet's coil until the desired field strength is attained.

The device is adaptable to superconducting magnets utilizing large currents, since it is designed to eliminate the large power supply required to energize such magnets.

Applications include electric power equipment, space propulsion engines and radiation shielding in outer space.

Circle No. 231 on Subscriber Service Card

Motion Compensator

Compen-Theta TM Model AAC-252R has been developed by American Aerospace Controls, Inc. The 3-in. dia. component is adjustable to a repeatable accuracy of ±30 seconds of arc over a total adjustment range of 2 degrees. The device can be used with tandem-mounted synchros, resolvers and other system output components as large as BuOrd size 25.

There are 36 radial adjustment points on the compensator at 10-degree intervals around the body. Compen-Theta is used for correcting magnetic variations in compass systems, compensating for phase shift difference in rotary capacitors.

Circle No. 232 on Subscriber Service Card

DC Panel Voltmeter

Trio Laboratories, Inc., has available a transistorized d-c panel voltmeter, offering d-c measurements with an accuracy of 0.5% full scale allowing a line voltage fluctuation from 105

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Circle No. 10 on Subscriber Service Card

to 125v ac. A minimum input impedance of 10 megohms for all ranges is said to essentially eliminate signal circuit loading effects.

Front-panel controls provide a selection of 12 ranges for full scale sensitivities from 0.1 to 500v dc, with 1:2:5 overlap.

Circle No. 233 on Subscriber Service Card

Coaxial Attenuator

Weinschel Engineering is offering a 10-db direct reading, variable coaxial attenuator that has little frequency change over the range from 2.5 to 12.0 gc.

The Model 953 can be used as a trimmer to balance power levels, for extending the range of power measurements, or as a simple level set. Small corrections to the calibration of insertion loss that apply at 2 and 10 gc are shown on a scale.

Circle No. 234 on Subscriber Service Card

Direct Reading Attenuator

Available from Microwave Components & Systems Corp., are direct reading attenuators, having frequency ranges from 3.95-18.0 gc. Calibrated to an accuracy of ±2%, over a 10% bandwidth at calibration frequency, this compact, direct reading unit provides up to 10 db of attenuation despite temperature and humidity changes. A friction-free, anti-backlash drive mechanism provides accurate determination of attenuation in 0.1-db steps.

Circle No. 235 on Subscriber Service Card

Temperature Sensor

Available from RdF Corp. is a JN series of RdF stikons®, making possible the production of temperature sensors with fast response and wide temperature range. The series utilizes CP nickel resistance wire sandwiched between sheets of high-temperature, resin-impregnated glass paper. This construction results in a thin, flexible sensor which can be bonded to flat or curved surfaces, and has a minimal thermal mass, permitting a response time as low as 20 milliseconds when properly bonded. It is also capable of temperature measurements from 320°F to 800°F.

Circle No. 236 on Subscriber Service Card

Accelerometer

A piezoelectric accelerometer to incorporate miniature impedance-matching electronics as an integral part of the transducer has been developed by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.

The piezoelectric sensing element and emitter-follower electronics have been combined into a single unit less than one cu. in. in volume. Claims are that this integral package effectively eliminates both noise and signal attenuation problems normally associated with crystal transducers.

The Type 40280 features 100-ohms output impedance operating to 250 peak-g from 6 to 6000 cps over temperatures from —65°F to 200°F. Voltage sensitivity is 20 peak-mv/peak-g at 77°F and 100 cps with a 50,000-ohm load. Output voltage is limited to 14 volts peak-to-peak without distortion at room temperature.

Circle No. 237 on Subscriber Service Card

Magnetic Logic

A CTL magnetic core-transistor-logic is being marketed by DI/AN Controls, Inc.

Each CTLA-4 card carries 4 independent magnetic-core transistor logic circuits. By appropriate backboard interconnection, each CTL can perform any logical function such as AND, OR, INHIBIT or COMPLEMENT—making available to the designer a complete logic system capability through the use of a single-card type. Mating receptacles and standard housings holding 21 or 42 cards are available.

Circle No. 238 on Subscriber Service Card

Glass-Enclosed Crystal

Glass-enclosed quartz crystals in frequency ranges from 2 to 100 mc have been developed by Keystone Controls, a subsidiary of Bulova Watch Co. The company claims superior aging characteristics compared to crystals with conventional metal enclosures.

Circle No. 239 on Subscriber Service Card

Ultrasonic Thickness Gage

A direct meter read-out ultrasonic thickness gage has been developed by Sperry Products, div. of Automation Industries, Inc.

The battery operated instrument can be used for thickness measurements of metals, plastics and other materials, as well as on corroded or curved surfaces.

Testing ranges cover from 0.1 in. to 5 in., with an accuracy on smooth surfaces of ±1% of full scale. Three power source options provide rechargeable battery operation—external 115 volts 50/60 cycle, external 12 to 14 volts dc. The unit is designed to withstand severe temperature and humidity environmental conditions for field test jobs.

Circle No. 240 on Subscriber Service Card

Servo Accelerometer

Systron-Donner Corp. has developed a miniature force-balance acceleration transducer. The Model 4303 measures 0.5-in. in dia. and 1-in. long. The 0.2% force-balance accelerometer is said to have uses in miniature gyro platforms, flutter studies of aerodynamic surfaces, human body instrumentation and other applications where minimum space and weight are required.

Circle No. 241 on Subscriber Service Card

Preselector Filter-Mixer

Gombos Microwave Inc. is marketing 3 models of a tunable preselector-mixer for use in the telemetry bands of 1435-1535 mc, 1700-1850 mc and 2100-2350 mc. Each of the similar packages combines in compact space a 4-section variable filter and a low noise hybrid ring balanced mixer. Operating frequency selection is by means of a single counter dial and related calibration data. The data can be provided in a form most suitable to needs.

Circle No. 253 on Subscriber Service Card

Vacuum Ionization Gage

A vacuum ionization gage, the GIC-200, is available from Consolidated Vacuum Corp. for reading pressures from 2×10^{-10} to 1×10^{-3} torr. A plug-in thermocouple accessory extends the range to 2 torr.

The tube is said to be bakeable to 450°C, with a built-in filament protection circuit adjustable from 1½ to 2 times full scale.

The unit incorporates an independent process control circuit that is adjustable from 15% to full scale. A light on the front panel indicates when the control circuit has operated.

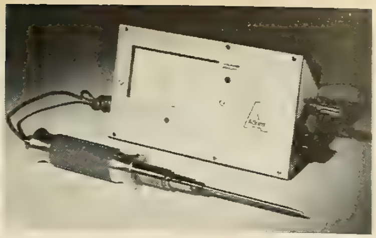
Circle No. 242 on Subscriber Service Card

Optical Laser Pump

Available from Electro Powerpacs, Inc., the Model 325-5000 volt Optical Laser Light Pump consists of a 0-5000-volt power supply with energy storage capability of 20,000 joules at the full 5000 volts. The unit contains the necessary variable voltage controls to operate at any voltage up to 500 volts.

Circle No. 243 on Subscriber Service Card

Electronic Thermometer



A line of portable, self-powered electronic thermistor thermometers for field use are available from Atkins Technical Inc. The units operate within a range of −153° to 577°F or −102° to 302°C. Standard units are said to have a precision of ±0.5 degree C (modified units, an accuracy of 0.1 C degree) and they provide easy temperature measurement of air, gases, liquids, surfaces and soft solids.

Circle No. 244 on Subscriber Service Card

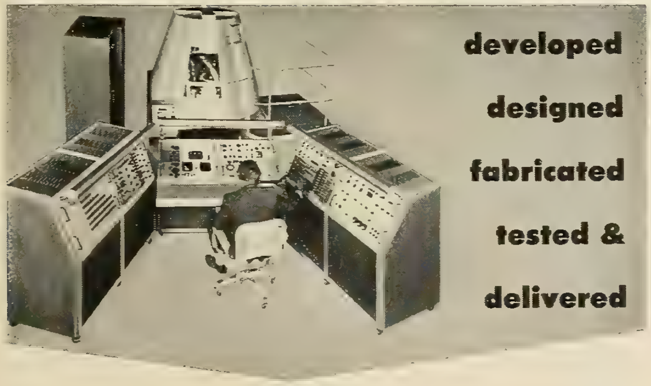
Microminiature Sensitor

Texas Instruments is marketing "Sensistor," positive-temperature-coefficient thermistors, in a microminiature glass package.

The device measures 0.06-in. long and 0.04-in. in dia. Designed for temperature sensing applications or temperature compensation in transistorized circuitry, the unit has a temperature coefficient of resistance of 0.7°C. Cyclical repeatability is 0.5-1.5 seconds.

The unit is available in resistance values of 10 to 1000 ohms with a 10% tolerance.

Circle No. 245 on Subscriber Service Card



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Micro Thinline Devices

Four Micro Thinline devices have been developed by TRW Electronics/ Pacific Semiconductors, Inc., subsidiaries of Thompson Ramo Wooldridge, Inc. to meet minimum thickness design requirements.

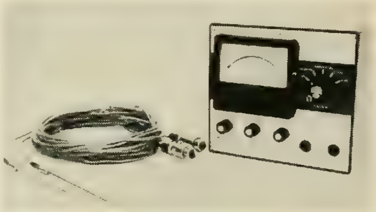
The PS3011 is a common cathode gate consisting of 4, 6, or 8 type IN3207 diffused silicon diodes; type PS3012 is a common anode gate of 4, 6 or 8 IN-3207 diodes; type PS3013 is a modular demodulator of four IN3207 diodes and type PS3014 is a 100-volt full wave bridge. All-welded, hermetically sealed construction is said to provide high shock and vibration resistance.

Circle No. 246 on Subscriber Service Card

Temperature Indicator

Winsco Instruments & Controls Co. has available the Model 4116 Differential Temperature Indicator, designed to measure and display both precision differential temperature and absolute temperature on one instrument.

The two differential scales on the meter are for 25° and 100°F temperature differences. The absolute scale is for —50 to 300°F.



The device is used for heat transfer measurements, differential thermal analysis, and with slight modification, in the cryogenic region.

Circle No. 247 on Subscriber Service Card

Frequency Meter

Optomechanisms, Inc., is offering a transistorized optical tachometer to be used in precise measurement of frequency of vibration, relative amplitude of vibration, and rotational speed measurements by remote sensing. It is said to measure mechanical shaft rotation up to 6,000,000 rpm, and sense frequency of vibration and relative amplitudes of 0 to 100 kc. Direct read-out is within ±1%.

Circle No. 248 on Subscriber Service Card

Power Rectifiers

A series of four high voltage silicon power rectifiers are available from Bendix Semiconductor Div.

These single-junction diffused silicon rectifiers have peak reverse ratings of 1000, 1500, 2000 and 2500 volts respectively and are said to deliver an output current of 10 amp d-c over an operating temperature range of —65° to 175°C. Features include low forward voltage drop of 2 volts maximum at IF-5 amp d-c because of the single-junction and low reverse current of 1 μamp d-c typical and 25 μamp d-c maximum at the rated peak reverse voltage and case temperature of 25°C.

Circle No. 249 on Subscriber Service Card

Two-Year Timer

The Bulova Watch Co. has developed a miniaturized timer that the company says can operate two years on its own power with a total error of less than 26 hours.

The instrument, using the Accutron electronic watch mechanism as its "timekeeping heart," was developed for satellites and other long-duration space projects.

Circle No. 250 on Subscriber Service Card

Hypot

A completely integrated corona-testing Hypot with direct current output of 30 kv at 5 ma. complete with built-in corona pickup network and detector facilities, has been developed by Associated Research, Inc.

The Model 5452 provides corona-free output adjustable from 0 to 30,000v d-c, with output leakage current metered in ranges of 0-50/500/5000 microamperes.

The unit detects and displays on a built-in oscilloscope minute traces of corona under high d-c voltage stress, whether caused by voids within the insulation, insufficient clearances, sharp terminations, or other defects.

Circle No. 251 on Subscriber Service Card

Sub-Min Thermostat

A snap-acting thermostat for appliances and electrical equipment applications has been developed by Elmwood Sensors, Inc.

The # 2400 is available with a high-temperature phenolic or ceramic base and is designed for heavy electrical loads. The unit is rated for 120v and 240v, and the thermal rating for the phenolic base type is 400°F max. to —100°F min., and for the ceramic base, 600°F max. to —100°F min.

Circle No. 252 on Subscriber Service Card

Loran-C Receiver

Time synchronization to an accuracy of a microsecond or better is claimed by Pickard & Burns, Inc.'s fully transistorized Model 601-A Loran-C receiver, which weighs approximately 10 pounds. A whip antenna with ball

WORLD SPACE DIRECTORY COMPLETE MISSILE/SPACE REFERENCE GUIDE

Use the new Spring Edition to locate key missile/space EXECUTIVES:

UNITED STATES GOVERNMENT: Dept. of Defense, NASA, Army, Navy, Air Force, AEC, Small Business Administration, related House, Senate, and Joint Committees.

INDUSTRY: Major missile/space manufacturers, component missile/space manufacturers.

INDUSTRY REPRESENTATIVES: U.S. industrial representatives (U.S. and foreign offices), foreign industrial representatives (North American offices).

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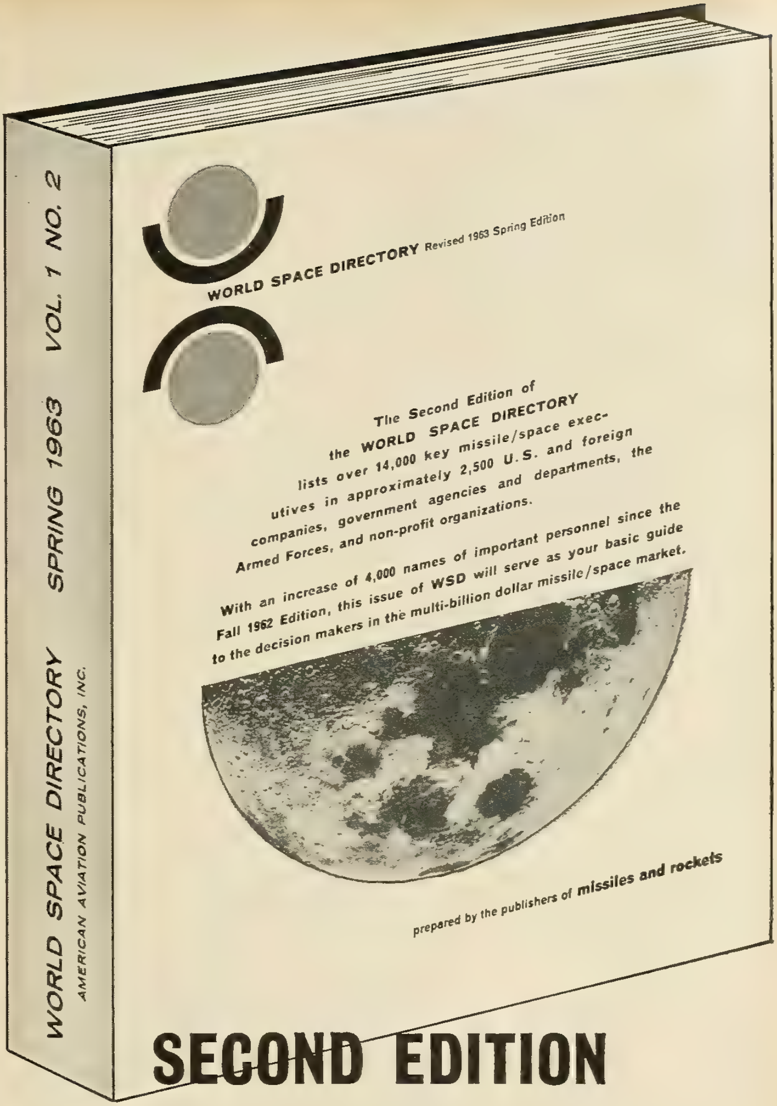

WORLD SPACE DIRECTORY SPRING 1963 VOL. 1 NO. 2

AMERICAN AVIATION PUBLICATIONS, INC.

WORLD SPACE DIRECTORY Revised 1963 Spring Edition

The Second Edition of the WORLD SPACE DIRECTORY lists over 14,000 key missile/space executives in approximately 2,500 U.S. and foreign companies, government agencies and departments, the Armed Forces, and non-profit organizations.

With an increase of 4,000 names of important personnel since the Fall 1962 Edition, this issue of WSD will serve as your basic guide to the decision makers in the multi-billion dollar missile/space market.

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socket mounting is included. An all solid-state device designed for battery or socket power operation, it amplifies signals to peak levels of two volts undistorted. Three chassis elements, a low noise preamplifier, a power supply and a carrier receiver are mounted on a 19-in. relay rack panel and tray configuration.

Circle No. 254 on Subscriber Service Card

Silicon Transistors

Westinghouse Semiconductor Div. is marketing 30-ampere NPN fused silicon transistors featuring low saturation and thermal resistance.

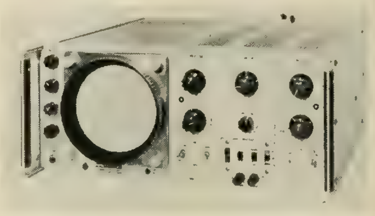
The high-power transistors, series JEDEC 2N2757, have current ratings to 30 amperes and voltage ratings to 250v. Typical saturation resistance is 0.037 ohm. Three gain classes have a minimum gain of 10 at 10, 15, and 20 amperes. The transistors feature power ratings up to 200 watts and low thermal resistance ($\Theta jc = 0.50°$ C/watt). Junction operating and storage temperature limits are from −65° C to 175° C. They are designed for applications such as lightweight regulators, amplifiers, high-power inverters and other high-power switching circuits.

The transistors have a double-ended case that offers ease of mounting, high power capability and light weight.

Circle No. 255 on Subscriber Service Card

Oscilloscope

A light weight 200 UV/CM sensitivity oscilloscope has been developed by Du Mont Lab. Div. of Fairchild Camera and Instrument Corp. Type 704 features equal amplifiers and bandwidth from dc to 500 kc. Critical circuits utilize silicon semiconductors, and internal construction is modular for accessibility. The cathode-ray tube is driven directly from transistorized amplifiers.



Circle No. 256 on Subscriber Service Card

Reed Vibrometer

Korfund Dynamics Corp. has manufactured the Korfund Reed Vibrometer, a hand-held instrument said to have a high order of accuracy. Its uses include: (a) measuring vibration frequency and amplitude; (b) determining the direction of maximum transmitted disturbances; (c) locating the cause of unwanted noise due to resonant vibration; and, (d) measuring the speeds of rotating equipment where shafts or rotors are not readily accessible. In addition, it can be used to analyze component frequencies of complex vibrations.

Circle No. 257 on Subscriber Service Card

Capacitor Test Unit

A test set which automatically measures the characteristics of tantalum capacitors is being marketed by the RCA Electron Tube Division.

RCA says the device prints out characteristics of a capacitor under test in only eight seconds and that the test set may be used for product evaluation, quality-control statistics, and vendor component evaluation.

The test set compares the capacitance and dissipation factor characteristics of unknown capacitors with the known values of standard capacitors. The results are presented as a percentage difference. Leakage current characteristics of the unknown capacitors are recorded in microamperes.

Circle No. 258 on Subscriber Service Card

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

Rocket nozzles and convergent-divergent cones made of Great Lakes Carbon Corporation's **HLM-85** grade graphite are standard in the first stage solid propellant motor developed by Thiokol Chemical for the Minuteman missile.

GLC's **HLM-85** graphite is distinguished by high density, great erosion resistance and economy of performance.

HLM-85 graphite is in full production. Ample supplies are available in a wide choice of sizes and shapes.

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Circle No. 23 on Subscriber Service Card

SPDT Diode Switch

Antenna and Radome Research Associates has available a broadband SPDT solid-state microwave switch, said to cover the frequency range from 100-2500mc and accomplish high speed channel switching while having a high isolation and low insertion loss. Termination of a third port also allows this unit to be used as an absorptive type voltage controlled attenuator or RF modulator.

Circle No. 259 on Subscriber Service Card

Tantalum Capacitor

A series of tantalum wet slug electrolytic capacitors, conforming to MIL-C-3965/4, has been developed by the International Electronic Industries Div. of Standard Pressed Steel Co.

The CL 64 and 65 subminiature capacitors are polar units said to be suited for low voltage transistor applications such as filtering, coupling and by-pass in both military and industrial electronic equipment.

The voltage range is from 6-100v dc. Capacitance is 4.7-560 microfarads, with ±20% tolerance. Operating temperature range is —55 to 85°C without derating, and to 125°C with derating.

Circle No. 260 on Subscriber Service Card

Digital Voltmeter

An all-electronic digital voltmeter is being marketed by Hughes Aircraft Co.'s vacuum tube products div.

The Model 5000 claims full five-digit readout, readings from 100 microvolts to 999.99 volts, an accuracy of 0.01% of reading, using four ultra precision resistors.

Circle No. 261 on Subscriber Service Card

Clip-Mount Resistors

A new type MS series of metal sheath clip-mount resistors designed to meet severe environmental conditions where physical ruggedness or clip-mounting is desired has been introduced by California Resistor Corp.

Coated with silicone and molded in sheath with special high thermal conductivity compound, the MS resistors are said to meet or exceed requirements of MIL- R-26C. Nickel plated brass provides rugged exterior for clip-mounting. Wattage is greatly increased over free-air when clip-mounted to chassis. MS resistors are available from stock in five sizes: 3 watts through 10 watts; 0.5 ohms to 200k ohms.

Additional features include complete welded construction terminal-to-terminal; maximum wire coverage of core for cooler operation and reliability; high

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Circle No. 13 on Subscriber Service Card

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A scintillation sphere of NE 102 Phosphor receives cosmic radiation in Britain's first satellite Ariel. The data is transmitted to tracking stations and two computers at Aldermaston analyse the transmissions.
NE 102 Phosphor and related electronic probes go up in balloons and rockets for upper atmosphere studies.
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Circle No. 14 on Subscriber Service Card

MANAGEMENT SEMINAR ON
STATISTICAL PREDICTION TECHNIQUES

ATTENTION: Reliability directors, quality control managers, controllers responsible for warranty costs analysis, and engineering and production supervisors.
A list of a few of the topics to be discussed are:

★ Prediction Principles
★ Weibull Analysis
★ Graphical Estimation
★ Field Failure Analysis
★ Analogy—"Sudden Death" & Field Data
★ Confidence Indices for Observed Changes
★ Special Formulas & Nomographs for Confidence
★ Warranty Cost Estimation
★ Graphical Variation Research
★ Experimental Designs Analyzed on Probability Paper
★ Supply and Demand Cyclical Behavior and Its Prediction
★ Predicting Market Trends from Observed Data
★ Blocks of Failed and Suspended Items
★ Methods of Reducing Testing Time
★ Making the Most of Advanced Statistical Evidence

Seminar Leader: Leonard G. Johnson, reliability scientist, GM Technical Center and an instructor at the Detroit Research Institute has developed many original concepts and techniques in reliability and management prediction statistics. Over many years he has solved complex warranty costs and market trend problems. He is the author of numerous publications and has received national recognition for his contributions.
The Seminar will be held from June 24 to June 28, 1963, 9 a.m. to 5 p.m., Pick-Fort Shelby Hotel, Detroit, Michigan.
Another program of importance offered by the Detroit Research Company is MANAGEMENT MATH. This is a three-week course on elementary analysis in the solution of business and technical problems, covering basic math from algebra through calculus. June 3 to June 21, 1963.
Request brochure.

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Circle No. 15 on Subscriber Service Card

THERMODYNAMICISTS FOR SPACE AND RE-ENTRY VEHICLES

Several projects at Hughes require engineers qualified in fields of space vehicle thermal control or re-entry vehicle aerothermodynamics.

Projects include the Surveyor Lunar Landing vehicle, Syncom synchronous communications satellite, advanced anti-missile missiles and a number of classified projects. Applicants for space vehicle thermal engineering positions should have knowledge of radiation heat transfer; specific experience in the design of thermal control systems, surface treatments or thermal vacuum testing is highly desirable.

Re-entry vehicle thermal engineering positions require recent experience in hypersonic real gas dynamics; familiarity with heat shield design; re-entry observables and anti-missile systems requirements is desirable.

Advanced degree preferred with three to ten years' experience.

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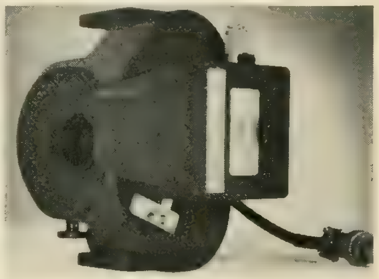
Circle No. 262 on Subscriber Service Card

Electronic Programmer

Northridge Research Inc. has completed development and programming with the "Cinetracker" and "Pulsemaster" 35mm Data Recording Cameras. Northridge says that by using the programmer it is possible to remotely program the 35mm Cine-pulsed cameras without extensive modification, and that this added feature is a breakthrough in the art of controlling motion picture cameras used for data gathering purposes by instrumentation engineers. During the development stage, consideration was given to keeping the design compatible with cameras being used in the field. Only a slight factory modification is needed for the majority of the cameras previously produced.



Circle No. 263 on Subscriber Service Card

Capacitor Test Unit

An RCA test set to automatically measure the characteristics of tantalum capacitors has been developed by the RCA Electron Tube Div.

The device is designed to print out characteristics of a capacitor under test in only eight seconds. The test set may be used for product evaluation, quality-control statistics, and vendor component evaluation.

Circle No. 264 on Subscriber Service Card

Circuit Board Terminals

Dynamic Design Corp. is marketing the "Cirkut Socket" line of circuit board terminals which are designed to provide an unusual mechanical gripping action that joins electrical component leads to the board surface. The technique, already proven on advance military and space programs, accelerates the production and assembly of electronic welded or printed circuit cards.

Additional features include rigid component retention, reduction of materials for lead bending and associated labor, elimination of assembly jigs and component masking. The socket terminal acts as its own heat sink for temperature sensitive components. The terminals are gold plated phosphor bronze (bifurcated), which make four points of contact on the mating component wire lead. After being inserted into the circuit board holes, they are rolled or funneled into space as simply as eyelet installations.

Circle No. 265 on Subscriber Service Card

Circuit Board Jumper

A new ribbon-cable flexible jumper for connecting two or more printed circuit boards has been designed by Digital Sensors, Inc.

Ribbon cable used in the jumper provides resiliency for essential flexing in applications characterized by extreme vibration and shock. In addition, configuration of the jumper insures complete mechanical isolation for each conductor. This jumper is fabricated by the Flex-Weld technique which permits welding pins directly to the ribbon cable conductors without stripping insulation from the flat conductor.

Circle No. 266 on Subscriber Service Card

Crystal Frequency Standard

Reeves-Hoffman Model S-2075 is an ultrastable oscillator said to provide a standard frequency reference under severe environmental conditions. The standard is solid-state and transistorized throughout. Double ovens, proportionally controlled, insure optimum circuit stability and ultimate performance of the 2.5 mc AT-cut, fifth-overtone crystal.

At a phase stability of 7×10^{-3} degrees, peak-to-peak, measured for 20 milliseconds, a spectral purity of 0.1 cycles bandwidth at 25 kmc can be realized. Drift rate of the standard is 2×10^{-11} parts per day. The frequency standard provides output frequencies at 100 kc, 1 mc and 5 mc and is packaged for rack mounting with a panel height of 5¼ inches.

Circle No. 267 on Subscriber Service Card

Transistorized Encoders

Dynacoustic Laboratories is marketing a new series of transistorized encoders and decoders suitable for varied communications applications. Typical uses are tone squelch, selective calling, operation of repeater transmitters, activation of TV satellites and telemetry.

Silicon transistors and temperature compensated tuned circuits provide operation over a temperature range from −50°F to 175°F. Units utilize keyed tones within 1,500 to 20,000 cps, operate from any 12 volt source with exceptionally low current drain.

Versatile design and small physical size permit internal mounting in communications equipment. Heavy gage dustproof covers for external mounting are available.

Circle No. 268 on Subscriber Service Card

Deviation Bridge

A digital resistance deviation bridge intended for use by semi-skilled or untrained personnel in quality assurance and incoming inspection departments, has been developed by Solartron, Inc., a subsidiary of Electro-Mechanical Research, Inc.

The new instrument, designated the Model EM 1291.2A, is a self-balancing precision bridge that measures the percent deviation of resistors from rated value and displays deviation directly as a percentage in a five-window in-line digital readout. The Digitohm is said to have the speed of a digital voltmeter and the accuracy of a precision, self-balancing Wheatstone bridge.

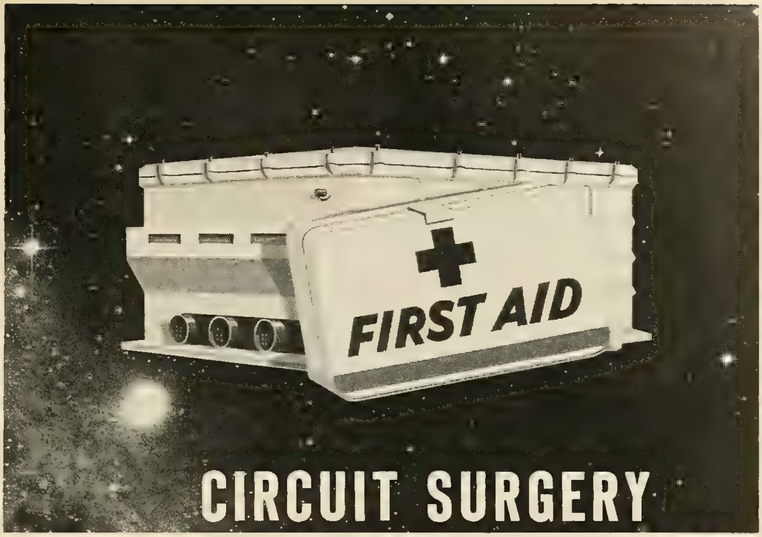
Circle No. 269 on Subscriber Service Card

Four-Terminal Rheostat

A four-terminal rheostat has been developed and introduced by Angstrohm Precision Inc. to provide exceptional standards capability in the resistance measurement field.

The new Angstrohm device is designed to set up 893 references resistance standard values in two digits, in the ranges from one ohm to 110,000 ohms. These standard values are obtained by direct transfer from five NBS-type reference resistors.

The rheostat is to enable users to establish resistance values at Rosa levels, without the need for complex mercury cups. Using the Angstrohm unit as a



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- Optical Coordinate Transfer Devices.

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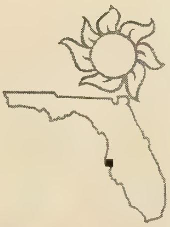

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Circle No. 17 on Subscriber Service Card

calibrating device, a conventional 0.1% bridge can be operated with 0.01% or better accuracy for all discrete resistance values within the one ohm to 110k ohm range. Many ratio values can also be obtained directly.

Circle No. 270 on Subscriber Service Card

Silicon Rectifiers

Diodes, Inc., has produced a new line of small, high voltage stacked silicon rectifiers. Peak inverse voltage ratings range from 1,500 to 25,000 volts; average rectified current up to 500 ma; and extremely low inverse current are claimed. The rectifiers are hermetically sealed. Large silver leads conduct heat from the center of the diodes and distribute it into special epoxy encapsulation, thus insuring minimum temperature rise at rectifier junctions.

Circle No. 271 on Subscriber Service Card

Sub-Miniature Capacitors

San Fernando Electric Manufacturing Co. has produced the cord wood line (Type CW), metallized mylar capacitors. They are molded, sub-miniature in size and cord wood module assemblies; 200v dc, —55° to 125°C with no voltage derating; MFD capacities from 0.001 through 0.10. West-Cap cord wood leads are solderable or weldable with a minimum of 0.0002 60/40 tinning.

Circle No. 272 on Subscriber Service Card

Transistorized Intercom

A transistorized portable intercommunications amplifier has been designed by Cambridge Electronics for applications in industry where voice exchange is necessary in noisy environments.

Designated Model CE-1300AC/R —this unit is a 19-in. rack mount with facilities designed to handle up to 20 microphone connections. The ac power supply is transistorized and has two watts of audio output.

Circle No. 273 on Subscriber Service Card

Electrolyte Seal

A seal to considerably reduce the probability of electrolyte leakage of wet porous anode tantalum capacitors, without the use of gels or resins, has been designed by Cornel-Dubilier Electronics Div., Federal Pacific Electric Co. The seal is on CDE's TX type capacitors, which have ratings of 6 to 125 volts dc, 4.7 to 560 mfd and —55 C to +85 C. Capacitance tolerances are standard at ±10% and ±20%.

Circle No. 274 on Subscriber Service Card

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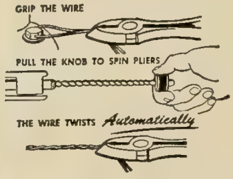

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Circle No. 19 on Subscriber Service Card

new literature

OPTICAL MASER SERVICES—Specifications on laser optics, dielectric coatings, and single crystals are available in a 12-page brochure published by Perkin-Elmer Corp. Technical data includes coating transmission curves, material transmission characteristics, and typical dimensional tolerances. A coatings and filters section gives full information on anti-reflection and high-reflectivity coatings, transmission filters, and mirrors available in 11 steps of reflectivity.

Circle No. 200 on Subscriber Service Card

POTENTIOMETER—Simple methods of obtaining in-circuit potentiometer noise characteristics that are more realistic than those provided by Equivalent Noise Resistance tests alone are described in a technical data bulletin published by Markite Corp.

Chart recorder traces show how these factors affect smoothness, and also provide a means of measuring this characteristic. The simple method used to obtain the traces, which involves monitoring the potentiometer output through a high-pass filter, is discussed.

Circle No. 201 on Subscriber Service Card

SILICON MODULE CATALOG—Computer Control Company, Inc., has published a 32-page catalog featuring one-megacycle Silicon S-Pac digital logic modules. The units meet a variety of applicable components and equipment mil specifications, and exceed continuous operating temperature requirements of MIL-E-5400, CL. 3 and MIL-E-16400, CL. 1.

Circle No. 202 on Subscriber Service Card

POTENTIOMETER—Centralab Div. of Globe Union, Inc., has published a 12-page engineering catalog to describe their EV4 style (MIL-R-94B) hot molded carbon potentiometers, known as Model 12. The unit is available with a wide range of terminals, shafts, bushings, and encapsulations. Dimensional drawings are shown for all standard hardware.

Circle No. 203 on Subscriber Service Card

DIGITAL SYSTEMS—Computer Control Co., Inc., offers a 36-page brochure detailing 3C activity in the design and development of specialized digital systems. A variety of 3C systems are described in each of six broad application areas: space, defense, industry, business, education and science/research.

Circle No. 204 on Subscriber Service Card

HIGH PURITY FILTERS—A technical bulletin published by The Meaker Co. describes RF-series, continuous duty solution filters, used in high-purity applications ranging from clarifying costly precious metal plating baths to protecting the purity of fluids. Details are given on the cotton or dynel filter elements with polypropylene cores; the pumps used; and the unit's construction, of inert plastics, which prevents contaminants from coming into contact with any fluid being handled.

Circle No. 205 on Subscriber Service Card

SPACE SIMULATION BROCHURE—A new 2-color brochure describing and illustrating its advanced space simulation facilities has been published by Ilikon Corp. The new brochure also contains charts of scientific data on the planets and satellites of the solar system.

Circle No. 206 on Subscriber Service Card

INSTRUMENT CATALOG—A 44-page catalog is offered by Keithley Instruments, Inc., describing their full line of electronic instruments for research and industry. The catalog is arranged into convenient sections covering measurements of dc and ac voltage, dc current, low and high resistance, dc and ac amplification, as well as sections on dc high-voltage supplies, nuclear instrumentation and space science instrumentation. Many sections are preceded by an introductory page discussing problems, applications and instrument selection applicable to the measurements involved. Useful selection charts are also provided.

Circle No. 207 on Subscriber Service Card

PRODUCTION TECHNIQUES—Techniques for the production of printed circuits and assemblies for high reliability applications are detailed in a technical booklet published by Industrial Circuits Company, a new division of Philips Electronics and Pharmaceutical Industries Corporation. The three-color, twelve-page booklet covers such considerations for purchasing executives and engineers as: various manufacturing methods and specific advantages and disadvantages of each; how to select electroplated coatings to enhance electrical or mechanical properties; eyelet versus plated-through-holes in two-sided printed circuit patterns; hints for selecting dielectric base materials best suited for the specific application of the circuit; and a discussion of multi-layer circuits.

Circle No. 208 on Subscriber Service Card

AMPLIFIER BULLETIN—A technical bulletin describing the Nexus Research Lab.'s all-silicon solid-state operational amplifier has been issued. Specifications and performance data for 10 Nexus amplifiers are included in the new Bulletin ATB-3

Circle No. 209 on Subscriber Service Card

STRUCTURES AND DYNAMIC TEST ENGINEERS FOR ADVANCED MISSILES AND SPACECRAFT

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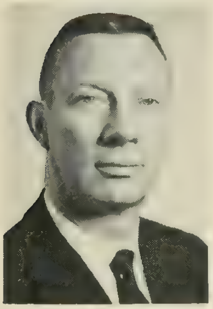
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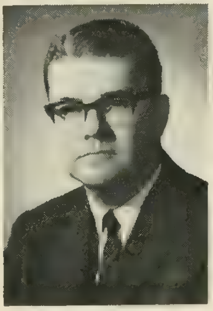
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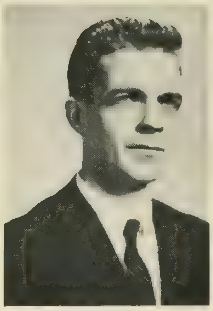
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Alexander D. Bruce: Elected chairman of the board and chief executive officer of the Vapor Corp., Chicago. **Laurance H. Gillick** named vice chairman of the board and **Arthur J. Loose** named president of the corporation.

John L. Mead: Appointed vice president-industrial relations for Aerojet-General Corp., El Monte, Calif.

Richard O. Driskell: Appointed export manager for Avco Corp.'s Electronics Div., Cincinnati.

James T. Dresher: Elected senior vice president of Fairchild Stratos Corp. and director of the Aircraft-Missiles Div., and Aircraft Service Div., Hagerstown, Md.

A. S. Chivers: Promoted to vice president of new business development, Barry Wright Corp., Watertown, Mass.

Caleb B. Hurtt: Named *Titan I* program director at Martin Co.'s Denver Div. **George Damstedt** chosen *Titan I* project engineer.

Elton N. Sherman: Appointed technical consultant for Defense Electronics, Inc., Rockville, Md.

Bruce Knudson: Appointed special projects engineer-advanced programs at Canoga Electronics Corp., Van Nuys, Calif.

Dr. John M. Teem: Elected a corporate vice president of Electro-Optical Systems, Inc., Pasadena, Calif. **Leslie J. Cook** elected a vice president.

H. Dickinson: Named executive vice president and general manager of Varec and Dynel, industrial instrumentation subsidiaries of Microdot, Inc., South Pasadena, Calif.

Robert H. Cline: Appointed assistant to the general manager of the Nortronics Div. of Northrop Corp., Beverly Hills, Calif.

Albert S. Humphrey: Appointed manager of the management survey team at General Dynamics/Astronautics, San Diego, Calif.

Dr. James A. Marsh: Promoted to associate group director of the space launching systems development group at Aerospace Corp., Los Angeles.

Stanley Goldhaber: Joined Wyle Laboratories, El Segundo, Calif., as manager of the newly formed Systems Engineering Div.

Col. Frank M. Townsend: Former director of the Armed Forces Institute of Pathology, Washington, D. C., appointed vice commander of the Aerospace Medical Div. at Brooks AFB, Tex.

A. B. Dod, Jr.: Appointed western manager-engineering and development of Phelps Dodge Electronic Products Corp., Los Angeles.

Richard S. Pauliukonis: Joined the engineering services division of Ryan Industries, Inc., Cleveland, as senior project engineer.

James W. Browder: Appointed marketing manager of space information systems, avionics and space electronics for the Librascope Div. of General Precision, Inc.'s Information Systems Group, Glendale, Calif.

Terry R. Savage: Appointed manager of systems and programming at Documentation, Inc., Bethesda, Md.

Alexander N. Beichek: Appointed assistant director of research and engineering for the Aerospace Div. of Walter Kidde & Co., Inc., Belleville, N. J.

William V. Miller: Appointed manager of the Washington, D. C., office of Pickard & Burns, Inc.

F. M. Thuney: Appointed director of manufacturing for Robertshaw's Aeronautical and Instrument Div. at Anaheim, Calif.

Jeff C. Campbell: Appointed internal marketing supervisor for Telememory Supervisory Control Systems at the Solid State Systems Div. of Motorola, Inc., Phoenix, Ariz.

Guy B. Entrekin, Jr.: Appointed a vice president of Bourns, Inc., Riverside, Calif.

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Aerospace Reliability and Maintainability Conference, sponsored by ASME, SAE and AIAA, Marriott Motor Hotel, Washington, D. C., May 6-8.

Instrument Society of America, National Aerospace Instrumentation Symposium, Jack Tar Hotel, San Francisco, May 6-9.

American Society of Mechanical Engineers, Production Engineering Conference, Netherlands-Hilton Hotel, Cincinnati, May 7-9.

Electronic Components Conference, sponsored by AIEE, EIA and IRE, International Inn, Washington, D. C., May 7-9.

National Aerospace Standards Committee of the Aerospace Industries Assn., 60th Meeting, Hotel Roosevelt, New York City, May 8-9.

Society for Experimental Stress Analysis, Spring Meeting, Benjamin Franklin Hotel, Seattle, May 8-10.

American Institute of Chemists Meeting, Warwick Hotel, Philadelphia, May 8-11.

American Institute of Aeronautics and Astronautics and Institute of Radio Engineers, National Aerospace Electronics Conference, Biltmore Hotel, Dayton, Ohio, May 13-15.

Instrument Society of America, National Power Instrumentation Symposium, Hotel Bellevue-Stratford, Philadelphia, May 13-15.

Industrial Research Institute, Semi-Annual Meeting, Fairmont Hotel, San Francisco, May 15-17.

Institute of Radio Engineers Symposium on Artificial Control of Biology Systems, University of Buffalo, Buffalo, N. Y., May 17-18.

National Telemetering Conference, sponsored by ISA, AIAA, AIEE and IRE, Hilton Hotel, Albuquerque, N. M., May 20-22.

American Society for Quality Control, Annual Convention and Exhibit, Sherman House, Chicago, Ill., May 20-22.

Institute of Radio Engineers, National Symposium on Microwave Theory and Techniques, Miramar Hotel, Santa Monica, Calif., May 20-22.

Design Engineering Show, New York Coliseum, New York City, May 20-23.

Aviation/Space Writers Assn., Silver Anniversary Meeting and News Conference, Hotel Adolphus, Dallas, May 21-24.

Lunar Surface Materials Conference, sponsored by Air Force Cambridge Research Laboratories and A. D. Little, Inc., Hotel Somerset, Boston, May 21-23. (Restricted).

JUNE

SAMPE Symposium on Space Power Systems Materials, Philadelphia, June 3-5.

National Electronic Packaging and Production Conference, Hilton Hotel, New York City, June 4-6.

Reliability Training Conference, sponsored by American Society for Quality Control, The Bishop's Lodge, Santa Fe, N. M., June 10-14.

American Society for Testing and Materials Annual Meeting, Purdue University, Lafayette, Ind., June 13-18.

AIAA Summer Meeting, Ambassador Hotel, Los Angeles, June 17-20.

American Nuclear Society Annual Meeting, Gatlinburg, Tenn., June 20-24.

American Institute of Electrical Engineers Summer General Meeting, Fontainebleau Hotel, Miami Beach, Fla., June 20-25.

Symposium on the Problems and Application of Dielectrics in Space, Westinghouse Research Laboratories, Pittsburgh, June 25-26.

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The Value of Value

WITH THE CURRENT Dept. of Defense emphasis on cost effectiveness, value engineering has become one of the most hotly debated disciplines within the industry.

DOD is pushing the VE program hard. Yet many industry critics contend the effort still is just so much window-dressing. The critics have parceled out to both DOD and industry management a share of the blame for the lagging VE effort.

Why all the fuss over VE? For several reasons.

Value engineers report that one of the toughest jobs is selling management on the concept. One says: "Management can't spare the time unless there is some incentive involved." He suggests that industry be given a fair share of VE savings on all contracts —with the ground rules firmly established in advance.

But even DOD willingness to pay for value received has not been sufficient to get the programs really rolling. Some companies are willing to let the program exist, particularly since the customer is willing to pay for it. But an approach with this attitude doesn't mean any real effort behind VE. In such cases, it exists as not much more than a briefing for interested visitors.

The VE situation, furthermore, is far too complex to be labelled as simply an industry-defense problem. VE is the subject of many a battle within individual companies. The internal dissension usually arises from two questions: Isn't VE something every good company has been doing all along without applying a formal name to it? At what engineering level should VE be applied?

Company management will have to determine the answer to the first question for itself.

How the last question is answered can touch off a heated battle between design engineers and value engineers. Many design engineers will contend that there is no need for an animal called a value engineer, that a good design engineer with value engineering concepts firmly in mind can do the job.

Some value engineers hold to the belief that they should participate in a project from the earliest stage. Others believe that value engineering can make its greatest contribution further downstream, after hardware design is complete.

DOD pressure for an effective value engineering program has brought many of these dissensions into the open. The new interest in the subject was evident at the recent Annual Convention of the Society of Value Engineers in New York. The turnout of government and industry specialists was unexpectedly large and the exchange was heated.

Barry J. Shillito, president of DOD's non-profit Logistics Management Institute and an admitted convert to VE, touched off much of the debate with a frank critique of the problems.

"Value engineers do themselves no good by overstating their capability or contribution," Mr. Shillito declared. "I do not consider value engineering a science. In fact, it is hard for me to consider VE as a separate technology, since so many of the basic elements of value engineering are drawn from many other disciplines. Generally, persons with sound broad technical knowledge are required to effectively apply value engineering, not technical specialists."

Mr. Shillito pointed out that the basic need of DOD and industry is to insure that there is an organized effort to analyze hardware with the purpose of achieving the required function at the lowest cost.

"If there is this assurance and management has the tools for stimulating this effort and maintaining cognizance of its progress, management is basically doing all that must be done in order to accomplish the goals of sound value engineering," the LMI president said.

We heartily agree with his implication that it doesn't really matter what you call it—just so long as you have it. This may distress some value engineers but it is a sensible approach.

Mr. Shillito also took value engineers to task on several other points that have been the subject of recent controversy:

- He suggested that value engineers drop their insistence that the department report directly to top management and concentrate instead on development of VE as a properly functioning unit whose importance and impact on company profits will be quickly recognized. "I have found that every function in any industrial organization can develop sound reasons for reporting directly to the general manager," he commented. "Value engineering is not an exception to the industrial status disease."
- He recommended that value engineering be concentrated in the area where it can do the best job —the functional cost analysis of hardware. It should not attempt to embrace other cost-reduction functions. "The total job to be done by VE is so vast already that one should not dilute one's capability by getting into areas that can best be handled by others," he said.
- He reported that an LMI project study team had found that not all VE efforts were concentrated in the areas of greatest potential. "It is vitally important to concentrate your efforts where they can do the most good, not where it is the easiest to apply them nor where it is least controversial," he insisted.

We believe that adherence by value engineers to Mr. Shillito's suggestions probably would do more to advance the VE cause than any other method. He is to be complimented for his frank analysis.

Design engineers, as the main target for VE, will remain sensitive to the intrusion of value engineers. But the sound approach outlined by the LMI president can do much to alleviate unpleasantness.

IT IS A PLEASURE to note that some of the severest criticism of VE is coming from its staunchest advocates. We also are pleased to observe that the Armed Services Procurement Regulations Committee, taking full note of industry and military criticisms, is drawing up revisions of the value engineering clauses for future contracts.

Properly applied, value engineering can make a valuable contribution to the industry. Frank discussion is leading to real progress in this area.

William J. Coughlin

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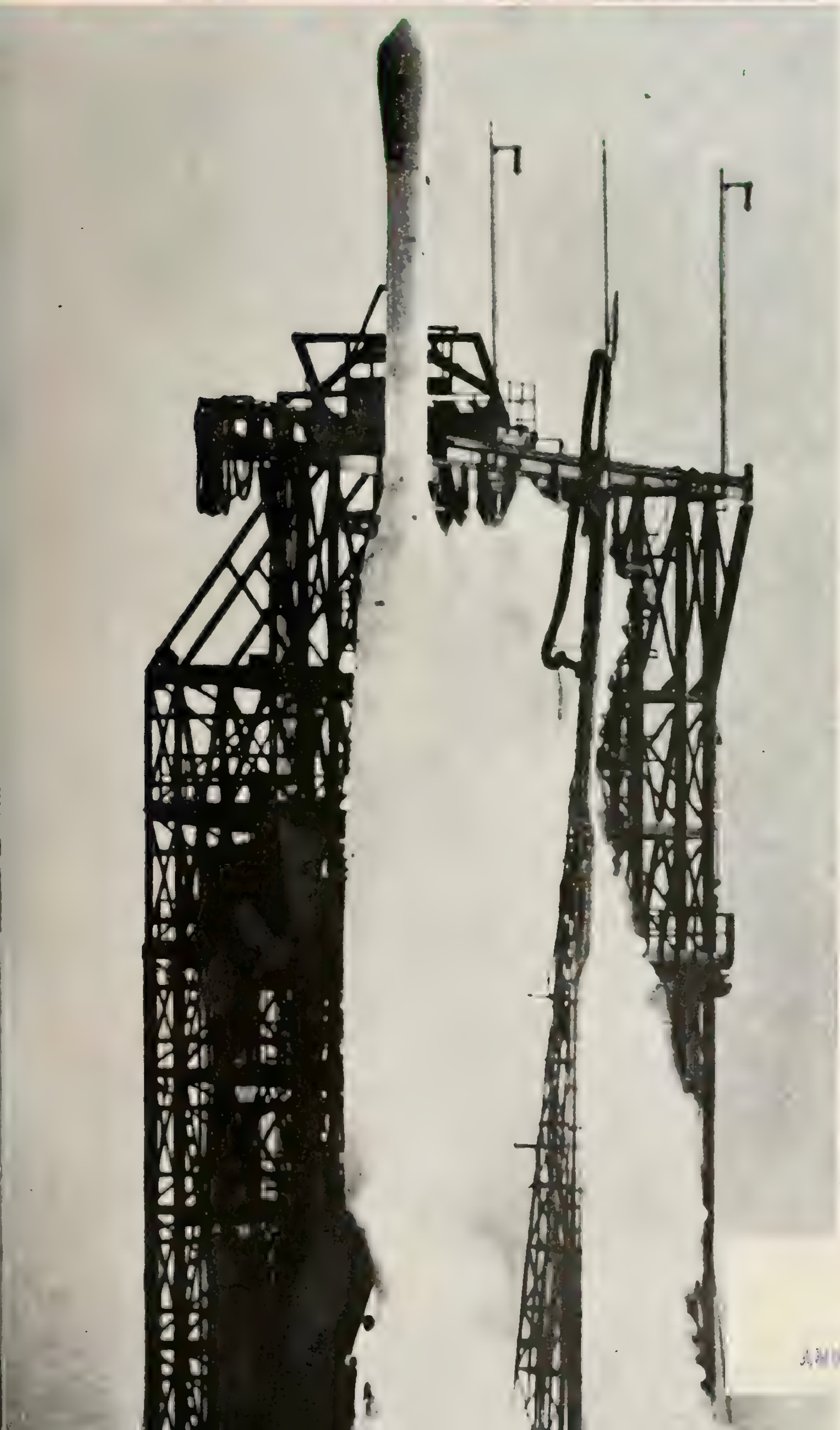
missiles and rockets

HE WEEKLY OF SPACE SYSTEMS ENGINEERING



Military Has Place In NASA's MOSS Plans

- Rangers May Go Unsterilized
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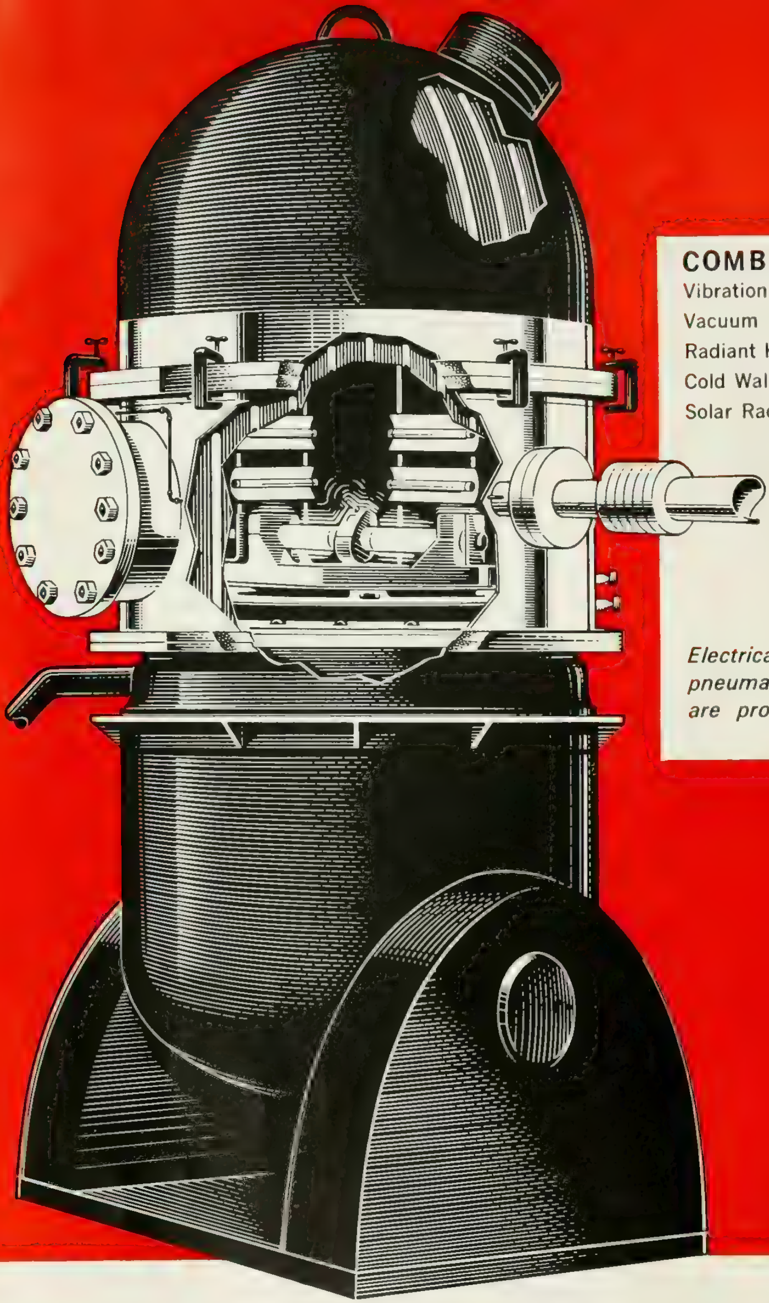
- NASA Works On Mars Trip

Second Telstar Takes Off



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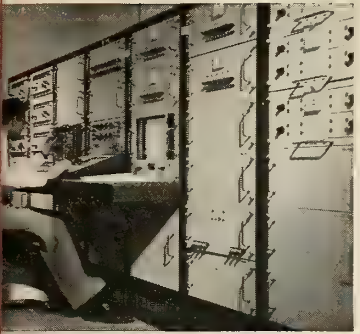

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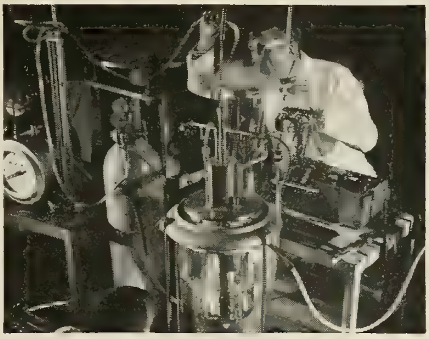

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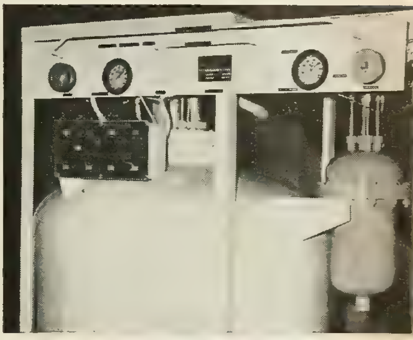

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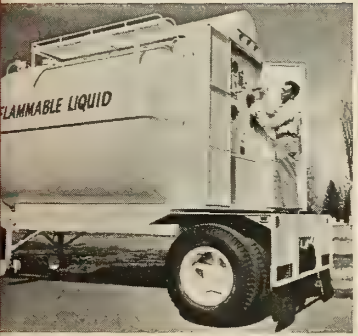

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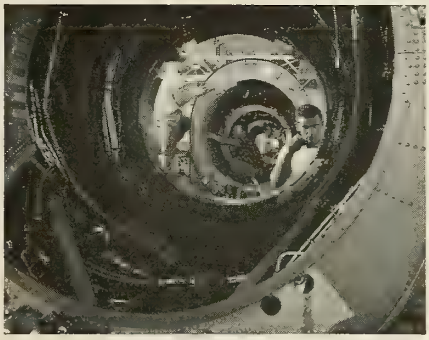

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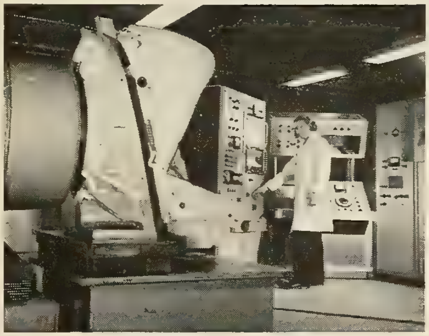

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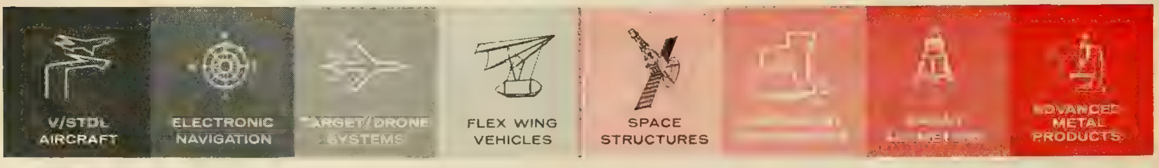

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 19 May 13, 1963

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THE COVER

Telstar II begins its climb into a better-than-anticipated orbit on May 7. The launch on a Douglas Delta booster—the vehicle's seventeenth consecutive success—stretches the U.S. lead in communications satellite operations. See p. 17.

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letters

The Bard on Decision-Making

To the Editor:

I enjoyed your April 29 editorial, "The Fallible Man." It raises the age-old conflict which the Department of Defense has faced and agonizingly reappraised on a number of occasions—whether to do something on the chance of a payoff, with some risk of failure, or to study the program to death.

I thought you might enjoy a quotation that proves that the problem is, indeed, age-old. Mr. Shakespeare thought of it long before Mr. McNamara and stated it as follows:

When we mean to build,
We first survey the plot, then draw the model;
And when we see the figure of the house,
Then we must rate the cost of the erection;
Which, if we find outweighs ability,
What do we then but draw anew the model
In fewer offices, or at least desist
To build at all?

—King Henry IV, Part 2
Act I, Scene 3

James P. McNaul
Neptune, N. J.

Seeking Publisher

To the Editor:

In M/R, April 22, a letter to the editor from Hamburg, West Germany, asked for help in finding the sense of all the abbreviations used in the industry.

Although it has taken me several years to prepare, I have a list of abbreviations taken from the major missile manufacturers. The complete document is about 46,000 words long. The task, recently completed, now needs a publisher. Could you help me locate a publisher who might be interested in publishing such a manuscript?

I will be very happy to furnish additional information, give sources, and even mail the manuscript for review and analysis, to anyone who might show an interest.

Arthur T. Cartier
4459 Rutgers Avenue
Salt Lake City 7, Utah

Engineering Documentation

To the Editor:

Col. Jackson's letter to the editor ("Engineering Documentation," M/R, April 29, p. 7) may touch off a veritable avalanche of comment, and provide material for not only a Master's thesis, but one on the doctoral level as well.

Documentation in the military is due for an exhausting overhauling, and for many aspects of it, much sooner than the relatively long-range indications suggested by Col. Jackson.

A copy of my letter to the Secretary of Defense which brought to light the fact that operational instructions had not received the benefit of electronic data processing . . . has been in circulation at various DOD echelons with reactions which would be amusing if it weren't for the fact that hundreds of millions of tax dollars are involved.

Starting with the Director of Maintenance Policy in the Office of the Assistant Secretary for Installations and Logistics, it has reached the area of the National Military Command System, where the basic idea—that of standardizing and coding operational references to facilitate central controls—is now presumably the subject of academic debate, long on theory and short on experience, as you so capably expound in your editorials.

I am of the opinion that this subject of documentation, which has mushroomed into a multibillion-dollar annual outlay, can stand a much greater airing than it is now receiving. As one of the senior laborers in this particular vineyard, I am at your service in any particular that may develop.

I genuinely appreciate your most constructive contribution to our defense effort.

James V. McCullough
McCullough & Associates
Management Consultants
Baltimore

Happy with Astrolog

To the Editor:

I continue to find your bimonthly Astrolog feature the single most helpful compilation of its kind. As a handy reference, it's tops!

Norman Wicks
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Public Relations
and Advertising
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Tarrytown, N.Y.

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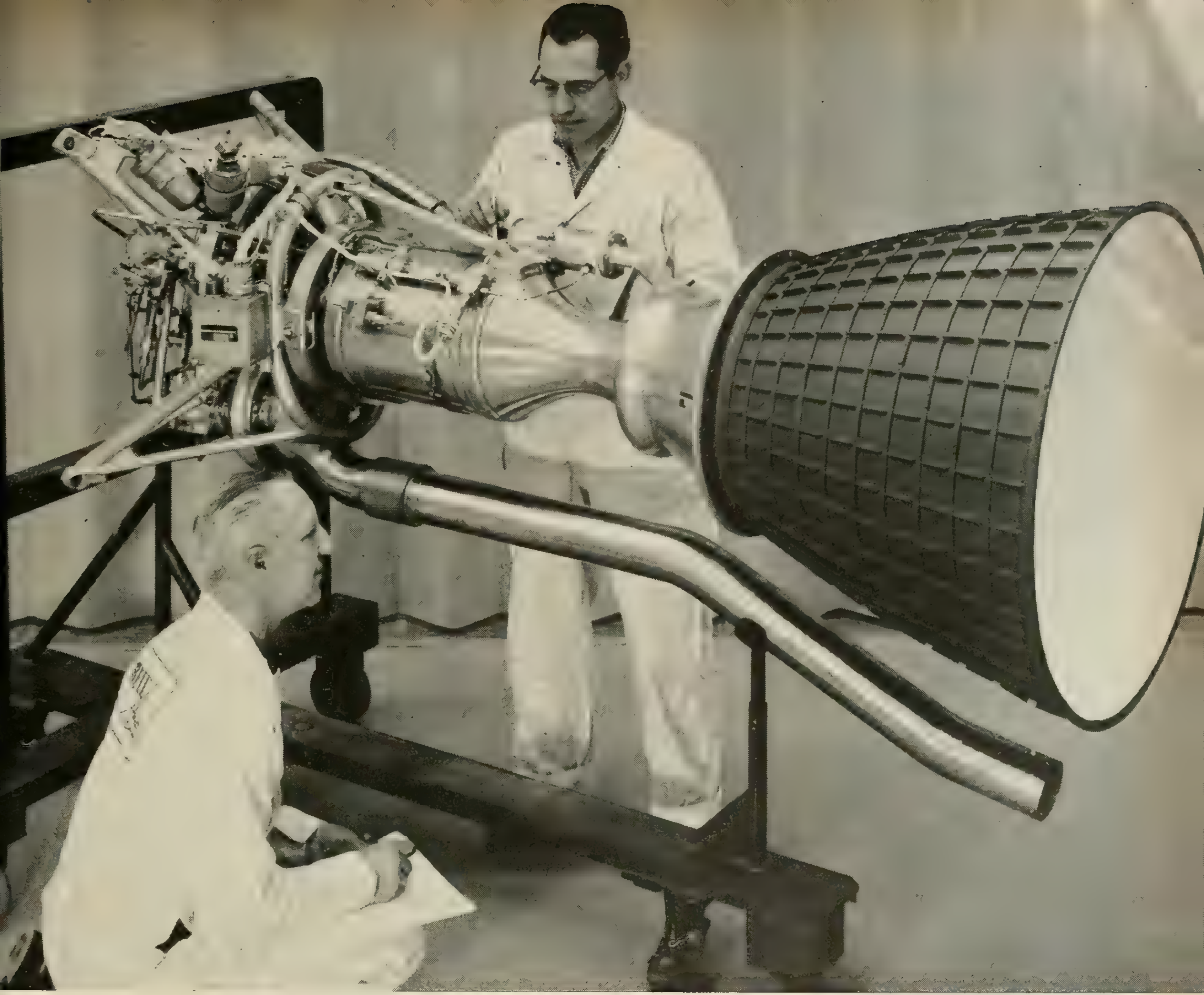

Bell Aerosystems' powerful Agena engine has an uncooled ceramic-coated titanium nozzle extension.

Titanium's compatibility with ceramics makes rugged, light-weight parts for ultra-high temperatures

One of the first practical examples of a unique partnership is now hard at work in space: the Agena's ceramic-coated titanium rocket nozzle extension.

Alone among structural materials, titanium has a coefficient of expansion (5.7×10^{-6} in./in./°F) close to vitreous materials. This useful compatibility opens up many possibilities for tough, strong parts that can be subjected to ultra-high temperatures. Where before only unsupported graphite and ceramics could withstand the searing blast of rocket gases, re-entry and the like, it is now possible to mate ceramics to titanium. Results...?

Take a look at the uncooled nozzle extension on the Agena. According to Bell Aerosystems Company, who designed and built the Agena engine, a base of titanium sheet coated with aluminum oxide was able to save 20 pounds over the original unsupported graphite part. Yet it was able to give equal heat resistance and at the same time provide a significant increase in strength and ability to withstand rough handling.

The uncooled titanium-ceramic nozzle extension has increased nozzle area more than 100% over the previous model, contributing to an improvement in specific impulse and superior performance. The restartable Agena engine has become the workhorse of the Air Force's Satellite Program, the Ranger, Mariner and other NASA programs.

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The Countdown

WASHINGTON

Military Space: Go or No Go in June

Air Force is studying a list of a dozen or more questions from Secretary of Defense McNamara about anticipated operations in space. The questions were sorted and sent to the most qualified subcommands—Ballistic Systems Division, Electronic Systems Division and Space Systems Division. Answers are due on McNamara's desk by May 23. His decisions on the status of *X-20, Titan III* and other military space programs are expected by the end of June.

Okay for MA-10 Flight Is Expected

Many NASA officials, both at headquarters and at Cape Canaveral, privately are voicing the belief there will be an *MA-10 Mercury* flight later this year even if *MA-9* is successful. Reason: the long gap of over a year between *MA-9* and the first manned *Gemini* flight late next year.

White House Says Wiesner to Stay

White House sources flatly deny Washington rumors that John Rubel, deputy director of Defense Research and Engineering, will replace Dr. Jerome Wiesner as the presidential science advisor. Not only did the sources eliminate Rubel as a replacement, they said Wiesner does not plan to leave the post in the foreseeable future.

NASA Management Approves New Cape Setup

Top NASA management has approved plans for organization of the Launch Operations Center at Cape Canaveral. The new organizational plan calls for 14 separate offices and divisions—including four assistant directorates for launch vehicle operations, instrumentation, projects management and administration.

ARIS Ships Expected to Stay at AMR

Defense Dept. officials charged with planning range instrumentation requirements for the national missile ranges deny reports from another high DOD office that one of the Advanced Range Instrumentation Ships (ARIS) will go to the Pacific to support new work in ballistic missile re-entry problems.

Congressional View of McNamara Shaken

The favorable opinion of Defense Secretary McNamara on Capitol Hill has been badly shaken by testimony in the TFX investigation. Failure of General Accounting Office to turn up any figures supporting McNamara's case jolted many Congressmen.

NASA Budget Gains Qualified Acceptance

The House Space Committee is not planning to withhold funds from any part of the manned space flight program as outlined in the NASA FY '64 budget. Instead, authorization for some programs will be reduced with the advice that the committee will be glad to approve a supplemental budget later—if the space agency really needs it.

NASA Asks for Ranger Proposals

NASA has requested proposals by June 1 for experimental payloads for *Ranger* spacecraft missions in 1965. It is expected that at least four flights will be made. Objective: landing a capsule on the Moon to transmit photos and data back to Earth. Other flights are expected to insure that at least 15 to 20 spacecraft will be built.

Vance Cites Capabilities of Pershing

Army Secretary Cyrus Vance officially has pegged the range of the *Pershing* missile at twice the published 200-mile range of *Redstone,* simultaneously crediting the Martin missile with double the warhead weight and greater accuracy.

INDUSTRY

Aerojet Reports Firing of Lunar Engine

Aerojet-General reports successful full-duration variable-thrust firing of a prototype lunar-landing rocket engine. Aerojet's approach is use of a pintle injector using only five pintles to achieve a 10-to-1 variable-thrust ratio. Grumman already has awarded a contract to Rocketdyne to develop a variable-thrust LEM descent engine using helium injection. Selection of a contractor to conduct a parallel program with another approach is expected. Aerojet says its full-scale engine, using *Titan II* storable liquids and developing a space-equivalent thrust of 10,500 lbs., met lunar-landing requirements of thrust level, stability and variability during the 445-sec. May 5 firing.

The Sky Is Falling

Note on females in space reported at the Aerospace Medical Assn. convention in Los Angeles: Centrifuge studies conducted by the University of California for NASA, National Science Foundation and Office of Naval Research show that hens are about seven times more resistant to long-term acceleration effects than roosters.

INTERNATIONAL

British Scorpion to Visit Paris

The Scorpion target tracking and illuminating radar used with the British Aircraft Corp. *Bloodhound* Mks. 1 and 2 will be featured on BAC's stand at the Paris Air Show next month. Scorpion is made by Associated Electrical Industries Ltd., which also is involved in the new CF.299 project. This is a guided weapons system for small ships.

Relay Transmits Brain Signals Across Atlantic

Electroencephalograph signals from a subject in the Burden Neurological Clinic, Bristol, England, recently were transmitted direct to the Mayo Clinic, Minneapolis, by means of NASA's *Relay* satellite. The subject's reactions to flashing light stimuli in Bristol were interpreted by a computer in the U.S. city.

NASA to Sign More Space Agreements

NASA is expected to sign international space cooperation agreements with both of the new European regional space organizations, the European Space Research Organization and the European Launcher Development Organization. The former will spend about $300 million over an eight-year period and the latter about $200 million over five years.

MA-9 Ready at Cape

NASA this week will attempt to rocket its fourth astronaut into orbit in what may or may not be the last flight of the *Mercury* Manned Space Flight series.

Air Force Maj. L. Gordon Cooper and his *Faith 7* capsule are scheduled for launch at 8 a.m. EST May 14 if no technical or weather problems develop. If successful, he will orbit the Earth 22 times and chalk up a 34-hour manned flight, a new U.S. record.

The space agency officially reports that *MA-9*, if successful, will be the last *Mercury* flight. They admit, however, that another spacecraft is being modified for an even more extended mission of three to four days.

Cooper and his spacecraft will be inserted into orbit on a heading of 072.5 degrees true, approximately 500 statute miles from Cape Canaveral. His altitude will range as low as 100 miles (perigee) to as high as 170 miles (apogee). If the mission continues through the 22nd orbit, retrofire will be initiated about 170 miles southeast of Kyushu, Japan, causing the spacecraft to land about 80 miles southeast of Midway Island.

On the first orbit, the *MA-9* pilot will leave the United States, cross the Atlantic, Africa, the Indian Ocean, Australia, the Pacific, Mexico and the southern United States in an orbit ranging 32½ degrees north and south of the equator. Beginning with the 16th orbit, the spacecraft will follow the Earth tracks of the initial orbits.

Cooper will be allowed a total of eight hours for sleep. This period is scheduled to begin—at the option of the pilot—in the ninth orbit during drifting flight. The ground station at Muchea, Australia, will send a wake-up signal to the spacecraft during the 15th orbit.

In addition to providing medical data on the effects on man of long periods of weightlessness, the *MA-9* flight will be a test bed for a series of flight experiments.

One of the most important calls for use of a special television camera to photograph the astronaut inside the capsule and external phenomena outside the spacecraft. It is possible that pictures of the flight will be flashed to Europe via AT&T's *Telstar* communications satellite.

The 10-lb. camera can be hand-held or mounted on a bracket to the right of the pilot's hand controller. A special telemetry transmitter has been added to the spacecraft to transmit the TV output directly to the ground during telemetry contact with the Mercury Control Center, the Pacific Command Ship (out of Japan), and Grand Canary Islands.

MTC 'No Strike' Pact Sought

Contractors and union representatives will meet May 22 in New Orleans in an effort to get a three-year "no-strike" agreement covering construction of NASA's Mississippi Test Center.

Purpose of the session is to work out agreements on wages, hours and working conditions to prevail during construction of the multi-million dollar MTC, at which NASA's *Saturn* rocket engines and stages will be ground tested.

Scheduling of the new session followed a May 1-2 preliminary session attended by 105 persons.

Paul Styles, industrial relations officer at the NASA-Marshall Space Flight Center, of which MTC is a part, said after the final session:

"While no definite agreement was reached, the conference developed a firm basis for future negotiations between the unions and the contractors."

J-2 Passes Test Series

The liquid hydrogen J-2 rocket engine has successfully completed the first in a new series of tests simulating the environment it will encounter in space.

Announcement of the recent tests was made by Rocketdyne, a prime contractor for the engine's development.

The J-2 (see photo) was fired at a simulated altitude in excess of 60,000 ft. It was a programmed 20-sec. run, conducted with the engine operating at full 200,000-lbs. thrust. It was the first in the new test series that will lead eventually to simulated altitude runs of durations up to 250 sec.

Thus far, test firings of J-2 engines have been conducted at sea-level pressures. These, too, will later be increased in duration, culminating in runs of up to 500 sec.

The J-2 engine is scheduled to make its first flight in 1965 and ultimately will be used in upper stages of both the *Saturn 1B* and *Saturn V* vehicles for the *Apollo* manned space flight program.

NASA Asks Lunar Base Bids

NASA has asked industry to submit proposals for an 18-month study program of a possible lunar base.

The studies will attempt to define a versatile lunar base system for use no earlier than the 1970's. Contractors will concentrate on the concept of an expandable, modular base, adaptable both to small outposts and to larger permanent installations housing up to 18 men.

The first study, for which proposals are due May 29, will consider the general concept of the complete base system. Within several weeks, additional studies will be initiated to examine in detail three of the major elements of the base—the life-support system, the nuclear power plant, and the regenerative fuel system for surface vehicles.

NASA's Manned Spacecraft Center, Houston, will manage the life-support system study. The Office of

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the Chief of Engineers, U.S. Army, will administer the power plant and fuel systems studies for NASA.

Other studies later this year will investigate additional technical and operational problems. A final overall study will consolidate the data from the other investigations, and present a comprehensive picture of the lunar base with its advantages and limitations, the NASA announcement said.

Shots of the Week

Telstar II, the United States second commercial satellite, was boosted into orbit from Cape Canaveral May 7 with the 17th consecutive successful firing of the Douglas Delta vehicle. The success raised hopes that the AT&T satellite might help transmit live TV pictures to Europe of Astronaut L. Gordon Cooper's space flight. (See p. 17.)

Other shots of the week:

- The *X-15* rocket plane streaked 212,000 ft. into the air over Edwards AFB, Calif., May 2 at speeds estimated up to 3,500 mph. The ship bore on its tail section an instrument to measure the Earth's normal heat radiation, against which detection satellites such as *MIDAS* may some day be able to sense missile launchings.
- West German scientists achieved a partial success in a May 2 firing of a three-stage "non-aggressive" research rocket 65 miles into the sky over a North Sea beach. The 18-ft., 450-lb., solid-fueled missile had been expected to reach 93 miles.

Sun Probe Studies Awarded

Three missile/space firms—Martin Co., General Electric and Philco Corp.—have been awarded four-month contracts to study concepts of an unmanned, scientific sun satellite.

Each of the contracts is worth about $140,000.

The firms were selected "to provide information in depth for the procurement of any future solar probe spacecraft should the program be fully authorized," according to an Ames Research Center announcement.

The probes under study would travel within 0.3 astronomical units, or about 28 million miles, from the sun. The so-called "heavy" probes would weigh about 400 lbs. and would be launched later in the decade.

Dr. Albert C. Hall, vice president and general manager of Martin's Space Systems Div., said the Martin study would be conducted in association with the University of Michigan's high-altitude research group under Leslie Jones.

In addition to preliminary design of the probe and its subsystems, Martin's Space Systems Div. will study scientific objectives and experiments, mission analysis, ground-support equipment, reliability estimates, flight operations, design requirements, development plans, cost funding schedules and advanced research and development items.

DR. THEODORE VON KARMAN died in Aachen, West Germany, on May 7, a few days before his 82nd birthday. Sometimes called the "Father of Astronautics," he lived a life of unparalleled contribution to science and human freedom.

After serving as an officer in the Austro-Hungarian air force during World War I, he began an engineering career that took him to the Orient and later to the United States. In 1939, he began working as a consultant to the U.S. Air Corps—a role he fulfilled for more than 20 years. Later, he won wide acclaim as an educator at Cal Tech, numbering among his students many who were themselves to become dominant figures in the opening of the Space Age. Still later, he founded the firm which is now Aerojet-General Corp. Recently, he had served as chief aeronautical adviser to NATO.

In one of a flood of statements following Von Karman's death, W. H. Pickering, President of the American Institute of Aeronautics and Astronautics, said his passing "leaves what may well be a permanent void in the U.S. and international aerospace technical community, for it is doubtful if ever again will one man influence the field as has this great scientist, engineer, educator, humanitarian and international personality."

(See editorial, p. 54)

DOD Eyes Source Selection

A new policy for making source selections for major military systems is being held in check by the Defense Department until the current furor over the TFX aircraft contract subsides.

Deputy Defense Secretary Roswell Gilpatric said the policy will not downgrade the role of the military in choosing the contractors for a system, despite the well-known dispute between military and civilian leaders in the Pentagon over TFX.

Gilpatric said the policy would be withheld for an undetermnied period because any enactment of it now would immediately be construed as an admission that present contractor selection process is faulty.

Gilpatric said the TFX would have been let to General Dynamics under any reasonable source selection method, but that some changes were being made.

The distribution of authority under the new procedures will be the same as at present, Gilpatric declared, with major programs like TFX, *Titan III*, *X-20* and similar ones going all the way to the Secretary for review.

Second West Ford Belt Set

The Air Force plans to try again in its attempt to orbit 50 lbs. of fine copper wires at an altitude of 2,000 miles for communications relay experiments.

The bundle of wires, dispersing in orbit, would form a thin belt of 40,000 miles circumference, acting as a reflector for ground-based communications.

Massachusetts Institute of Technology, through its Lincoln Laboratory, will conduct the experiments "in the near future" but no announcement will be made at the time of launch because of security classification policy and the fact that the launch itself does not signal the start of the experiment.

The technique used will be essentially the same as that used in the first attempt in October, 1961, during which a mechanical malfunction prevented dispensing of the small dipoles.

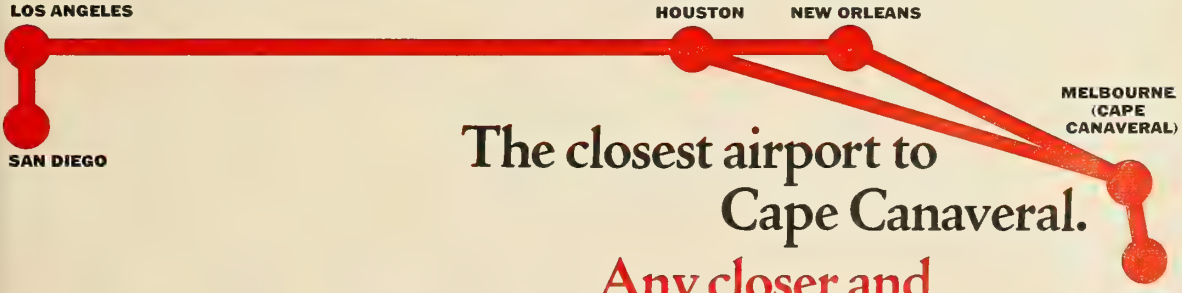
Saturn V Facilities Bids Due

The Army Corps of Engineers has called for bids on two Merritt Island construction projects for *Saturn V* facilities with a total value of $33.5 million.

Bids will be opened June 25 on a contract which will call for furnishing and erecting the structural steel for the *Saturn V* vertical assembly building.

Estimated cost of this part of the work has been set at $32 million. The contract will call for completion by Oct. 9, 1964.

Here's National Airlines' new thru-jet "Rocket-Run"



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MIAMI		9:37PM

WESTBOUND

	LEAVE	ARRIVE
MIAMI	1:35PM	
MELBOURNE	2:45PM	2:12PM
NEW ORLEANS	3:40PM	3:14PM
HOUSTON	5:00PM	4:32PM
LOS ANGELES	7:55PM	7:00PM
SAN DIEGO†		8:41PM

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AF role to be defined . . .

MOSS Plans Include Military

Effort, under NASA-DOD Gemini pact, to provide for military investigation of defensive and offensive capabilities in space

by Willard E. Wilks

Los Angeles—NASA plans for a large Manned Orbiting Space Station definitely include provision for military investigation of defensive and offensive possibilities in space, a NASA official has reported.

The comment came at the Aerospace Medical Association's manned space laboratory conference held in Los Angeles recently.

At the conference, guidelines on NASA's space station philosophy and requirements were outlined by E. H. Olling, head of the space station project office at the Manned Spacecraft Center in Houston.

Olling has no comment on military aspects of the project, but another highly placed official said that while the Air Force role in the program remains to be defined, the effort will be covered by the NASA-DOD *Gemini* agreement, at least according to current thinking. The spokesman added that planners envision "a platform adaptable to many investigations, including early-warning reconnaissance, surveillance, and defensive and offensive possibilities."

Immediate reaction of some Air Force observers to this indicated dissatisfaction with any NASA-led space station program. "In the end, it all boils down to a matter of time," said one. "A scientifically directed effort cannot move as quickly as military needs demand."

• **A second look**—Olling, describing space station approaches suggested or under study, said a small, zero-g laboratory investigated early in the *Apollo* program as a module of that system, "is again being seriously considered." Discontinued by *Apollo* planners because no well-defined need was apparent, the four-man station concept is now, he said, under intensive study by both NASA's Langley Research Center and the Air Force as "an interim approach to obtaining certain information needed early."

• **Ground rules**—However, Olling indicated that NASA is concentrating its major planning effort on large, deployable stations that will provide the ultimate requirements envisoned. He listed these guidelines:

—Launch of a relatively large station as a unit, utilizing *Apollo* launch vehicles and avoiding multi-launch operations, is desirable—as is automatic deployment.

—The station should provide for research and experimentation periods at least approaching the duration of Mars missions—about 18 months.

—It should handle a crew of at least 12, with crew expansion ability considerably beyond that. However, an initial operational capability with six men is desirable.

—The laboratory should be configured for general research use and be amenable to expansion or variation as requirements become better known or change. It should have both zero-g and partial gravity capabilities, to insure flexibility in research and operations.

—It should possess inherent stability and have mass control systems to minimize problems associated with orientation, docking and internal transfer of large masses.

—Adaptation of the *Apollo* Command Module as a six-man logistics vehicle is under consideration, and current investigations show the resupply spacecraft can be made reusable.

—Use of launch vehicles provided by existing programs is a major planning consideration. The first two stages of *Saturn V* are more than adequate for some stations under consideration.

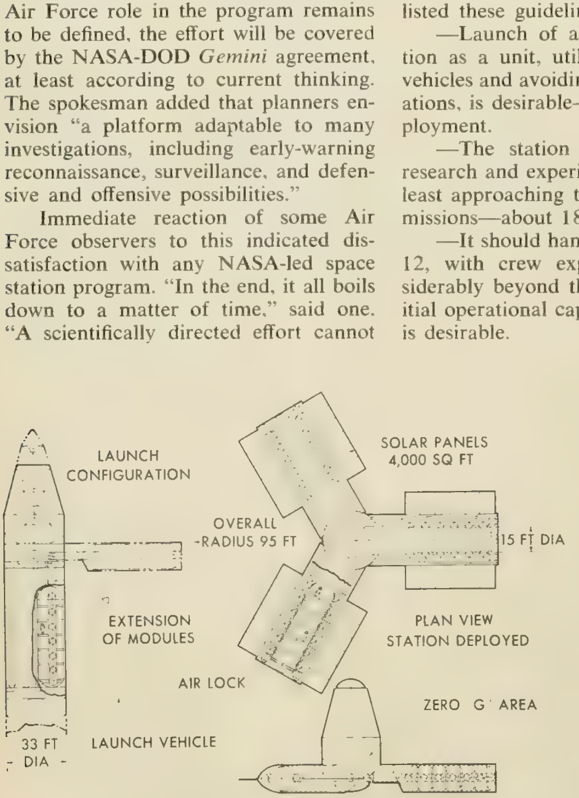
—Maintainability/repairability of onboard equipment will greatly influence design approach and systems configuration. Resupply must be minimized. Olling said the station would be launched unmanned, but with a crew of six in the logistics spacecraft atop the station. An important feature is that no extravehicular operations would be required for deployment.

—Safety considerations dictate use of redundant modules and stand-by evacuation capability for the crew.

—Olling indicated that a relatively large station proposed by Langley Research Center is more acceptable to present NASA thinking than orbital assembly configurations presented by some companies. The Langley proposal is a modified toroidal station composed of rigid cylinders. Carried into orbit as a compact unit and automatically deployed, it would have both zero-g and partial-g capabilities.

• **The last word**—Olling also described what he termed an example configuration derived from the guidelines he presented. The station, which apparently is the Manned Orbiting Space Station concept proposed by MSC (M/R, Feb. 25, p. 16), would consist of a hanger-type hub area and three radially deployed modules. Olling said it appeared to "illustrate amply the ultimate requirements that are envisioned."

Diameter of the deployed station would run up to 150 ft., and it would spin about its axis at 3 to 4 rpm. A retractable docking ring would allow the logistics vehicle to dock externally and then be towed into the hangar area. In launch configuration atop a *Saturn V*, the radial modules would be folded down into a vertical position and contained entirely within the diameter of the upper launch stage. ■



RADIAL module configuration space station.

Seen safe for two weeks . . .

NASA Defends Oxygen Atmosphere For Apollo

Officials rap critics, point to engineering factors complicating use of mixed-gas, deny withholding data

NASA HAS FLATLY denied charges that it is in any way endangering the lives or health of the *Apollo* astronauts by prescribing a 100% oxygen environment for their 14-day lunar-landing mission.

Space medicine experts in Washington told MISSILES AND ROCKETS the agency sees no reason to change its decision to use a single-gas, 5-psi atmosphere in *Gemini* and *Apollo,* in spite of criticisms from industry and medical officials at the Aerospace Medical Association's recent meeting in Los Angeles (M/R, May 6, p. 14).

D. Brainerd Holmes, director of the Office of Manned Space Flight, sharply rapped these critics in testimony before a Congressional committee, asserting that they should have come to the agency rather than air their views first to the press. Dr. Charles H. Roadman, Space Medicine head, also appeared before the House Science and Astronautics Manned Space Flight subcommittee and declared that, although it could not be ruled out that subjects might develop anemia in 100% oxygen, there was no risk in the 14-day mission.

NASA is so sure about its decision, the space agency's Dr. Joe Connor said in an interview, that it is confident that if the *Apollo* mission is extended to 18 or perhaps 25 days, the 100% oxygen life support system would go with it.

- **An engineering decision**—According to *Apollo* spacecraft director John Disher, a single gas was chosen primarily for engineering reasons. Original plans called for a mixed gas because of the unfamiliarity of altered environments, he said, but as design progressed it became evident that the complexities of the mixed-gas system were very great.

The complications of adding an inert gas are exponential, Disher told M/R. Not only does it increase weight, but more structure must be added to support it, and hence more fuel must be employed, further straining the launch vehicle. Leakage of the higher pressure is much greater, Connor added, and while *Apollo* is configured to hold pressure for five minutes with a ½-in. micrometeorite puncture, this would not be so at the higher pressure.

The other factor entering into the decision, Office of Aerospace Medicine officials said, is the fact that if the cabin is decompressed, the astronaut must switch to a 100% oxygen spacesuit with a great risk of decompression sickness. While it would be possible to put mixed gas in the spacesuit, the pressures would have to be near sea-level and mobility would be lost. The officials cited films of *Vostok 3* and *4,* in which the cosmonauts appeared to be virtually immobilized by their pressurized suits.

- **Physiological changes**—In spite of anemia, effects on vision, and other changes reported in papers on 100% oxygen exposure at the Aerospace Medical Association meeting, NASA doctors appear to be unanimous in believing that nothing has yet demonstrated that it would not be safe for 14 days.

Dr. George Knaupf, former Air Force bioastronautics chief at Cape Canaveral and deputy director of the office of Aerospace Medicine (Manned Space Flight), said his office has finished its testing for the 14-day mission, and has "not yet seen any effects that would compromise our mission."

He added that he was not convinced that the conditions that appeared in one of the tests would not have appeared in any group just picked off the streets. He labeled the conditions "interesting," in terms of longer durations, but reiterated that nothing has been shown to cause any concern about *Apollo.*

Dr. Connor added that it would not be surprising if a slight lowering in hemoglobin did occur at 7.5 psi with 100% oxygen, but said he did not consider this cause for alarm.

- **"Watchdog" debated**—NASA medics pointedly disagreed with privately voiced suggestions that an unofficial medical watchdog group should be formed to insure that medical requirements are not overruled by engineering or political expediency in future space programs. They said NASA has its own "watchdog" within its staff. But industry sources told M/R an effort is under way to set up such a group, perhaps funded by private foundation.

- **How decision was made**—NASA began evaluations of the single-gas atmosphere last summer, after *Apollo* engineers indicated their preference for this system. Contracts were let with the Air Force School of Aerospace Medicine, Republic Aviation Corp., and the Navy's Air Crew Equipment Laboratory for various tests. In addition, Dr. Knaupf said, the Lovelace Foundation was asked to review the problem and look at the results of these tests.

The space agency denied charges that it had not fully discussed the problem with both industry and the scientific community—and especially that results of the tests had been withheld. Officials said that the problem was discussed with the Gaseous Environments group of the Space Sciences Board's Man-In-Space Committee on several occasions, and at a Life Sciences committee meeting of the Aerospace Medical Association at Dayton, Ohio, on Jan. 29 and 30. If any results were not made available, they said, it was because the contractors may not give out data until it is coordinated with the source. ■

More Studies Funded

OART's Biotechnology and Human Engineering group is funding a number of extensive environment tests at the Air Force's School of Aerospace Medicine at Brooks AFB, Tex., and Aerospace Medical Laboratories at Wright-Patterson AFB, Ohio.

OART also told M/R that it intends to fund rather extensive tests at Republic Aviation Corp., which participated in the original tests.

Thirty-day tests are being supported by NASA through the Manned Spacecraft Center on 7-psi, 50% oxygen-50%-nitrogen environments.

The Navy is testing high-inert-gas ratios at its Groton, Conn., submarine center under the direction of Capt. George Bond, and NASA has professed interest in this work.

OART is highly concerned, according to Dr. William R. Brewster, over the effects of exposures to various concentrations of oxygen on cells and on the entire human body.

Some scientists object . . .

Rangers May Be Launched Unsterilized

After special committee report blaming process for failures, all sterilization may be dropped

by Hal Taylor

NASA MAY DROP all sterilization requirements for the *Ranger* spacecraft—a move which could stir new scientific criticism of the space agency.

Top officials have already waived rules requiring heat sterilization of major spacecraft systems. They are now considering a proposal to drop terminal sterilization of the spacecraft just prior to launch.

This would mean that along with its scientific payload *Ranger* would carry thousands of earthly micro-organisms to the Moon. This would kill the goal of many scientists—preservation of the biological integrity of the lunar surface.

The final decision will be made by Dr. Homer E. Newell, director of the Office of Space Sciences, in the near future, after consultation with various scientific groups including the White House's Science Advisory Board headed by Dr. Jerome Wiesner.

• **Pros and cons**—Relaxation of standards for *Ranger* program follows a report by a special NASA committee blaming sterilization techniques for many of the problems that caused five straight unsuccessful launches.

Approval of the dropping of heat sterilization—under which major subsystems were baked in ovens at very high temperatures—was revealed recently.

Terminal sterilization—which purifies the entire spacecraft by using ethylene oxide gas—is still an issue, a top official told MISSILES AND ROCKETS. "It's entirely possible that it will be waived," he declared.

The decision, he added, will be based on whether it is found that the terminal process affects reliability.

Final action, however, will also depend in large part on the degree of opposition in the scientific community.

Thus far, no scientist has publicly attacked the dropping of heat sterilization. But opposition has been voiced privately to the agency, and one well-known biologist has visited NASA to register a sharp protest.

Dropping of the final pre-launch sterilization could inflame the disagreement into public fireworks.

Even if there are no immediate repercussions, sterilization is clearly a problem which NASA will have to solve before capsules can be landed on Venus and Mars beginning in 1966. While some scientists believe that sterilization does not have to be adhered too closely in connection with the Moon, almost all feel it is absolutely necessary for missions to the planets, where some form of life may exist.

• **Ranger program plans**—While officials waited for a final decision on sterilization, they were pushing ahead with a new flight schedule and incorporating hundreds of design changes into future spacecraft.

Block III *Rangers*—including *Ranger 6*, which will be launched in the last quarter of 1963—call for a total of three missions. In mid-1964, four Block IV vehicles will be launched.

All seven missions will be designed to hard-land on the lunar surface with television pictures transmitted back to Earth just prior to impact.

The objective of Block V spacecraft—to be launched in 1965—is the landing of a capsule on the lunar surface which will survive impact. It is likely that at least several missions will eventually be approved.

• **Design changes**—A complete review of the program has resulted in hundreds of changes in the spacecraft design. Many will be incorporated into *Ranger 6* and all will eventually become part of the Block III and IV vehicles.

As a result, Block III vehicles will weigh in excess of 800 lbs., compared to the original 750-lb. weight. Block IV spacecraft will weigh even more—about 850 lbs.

The increased weight has forced one of the major system changes—the spacecraft structure will be built of the aluminum metal, rather than the magnesium used in earlier models. ■

NASA Re-entry Paraglider Nears First Flight Test

PARAGLIDER designed to measure micrometeoroid flux in lower regions of space was inflation-tested recently by Space-General Corp., El Monte, Calif., prime contractor for the NASA project. Rogallo-type craft was scheduled to be launched by an Aerobee rocket from White Sands Missile Range, N.M., on May 14, in first attempt by a winged vehicle to re-enter Earth's atmosphere. In inflation test, the paraglider, made of glass fiber coated with silicone rubber, was folded in 39-in.-long rocket extension, which was then placed in box. Photo sequence shows how explosive charge freed paraglider, which inflated to an aft spread of 20 ft., with three 14-ft. beams.

Second launch gratifying . . .

Time of Next Telstar Shot Uncertain

AT&T waiting on further planning of ComSat Corp.; Telstar II, Relay may both send pictures to Europe within a single week

PLANS FOR future *Telstar* launches are likely to remain in doubt until there is a clearer picture of the R&D plans of the ComSat Corp. (see p. 24).

There are four remaining flight models of the AT&T *Telstar,* two of which have been used as back-ups for the two successful flights. However, only one of these—the *Telstar II* back-up—has been partially modified with the improved radiation-resistant qualities of the second launched satellite, and it does not have *Telstar II's* evacuated transistors.

Bell Telephone Laboratories engineers point out that it would take several months to completely modify the *Telstar II* back-up. Hence it is unlikely that a third launch will take place for at least two months.

- **High success**—*Telstar II* was launched by a Douglas *Delta* booster from Cape Canaveral at 7:38 a.m. EST on May 7. It thus joined NASA's *Relay* communications satellite, which had been whirling around the Earth since its launch on Dec. 13.

AT&T officials immediately declared that *Telstar* was in a nominal orbit and that spacecraft telemetry was being received by three tracking stations.

They said the orbit was even better than had been expected. It had an apogee of 6713.3 miles, a perigee of 604 miles, and an orbital period of 225.3 minutes. The planned orbit called for an apogee of 6560 miles, a perigee of 575 miles, and an orbital period of 221 minutes.

On Pass No. 10, the satellite carried out its first international color video tape TV transmission. A French station reported it missed the first portion of the transmission, but enjoyed excellent reception of the remainder. The black-and-white video tape that followed was received in excellent condition in both France and Britain.

- **Double play**—This week, the U.S. will attempt a new Space Age feat—transmission of television pictures to Europe using two different orbiting communication satellites, NASA's *Relay* and AT&T's newly launced *Telstar II.*

Pictures of the *MA-9 Mercury* spaceflight—if it is launched on schedule—will be flashed to Europe on pass 1183 of the *Relay* satellite.

Communication network officials have indicated that they will also transmit flight pictures to Europe via *Telstar,* but the exact orbital pass has not been decided. If the transmissions are successful, the current U.S. lead over Russia in ComSat development will be even more apparent.

Its higher-than-expected altitude will enhance the chances of one of the satellite's most important experiments--the determination of how ComSats can avoid the effect of the artificial radiation belt surrounding the Earth.

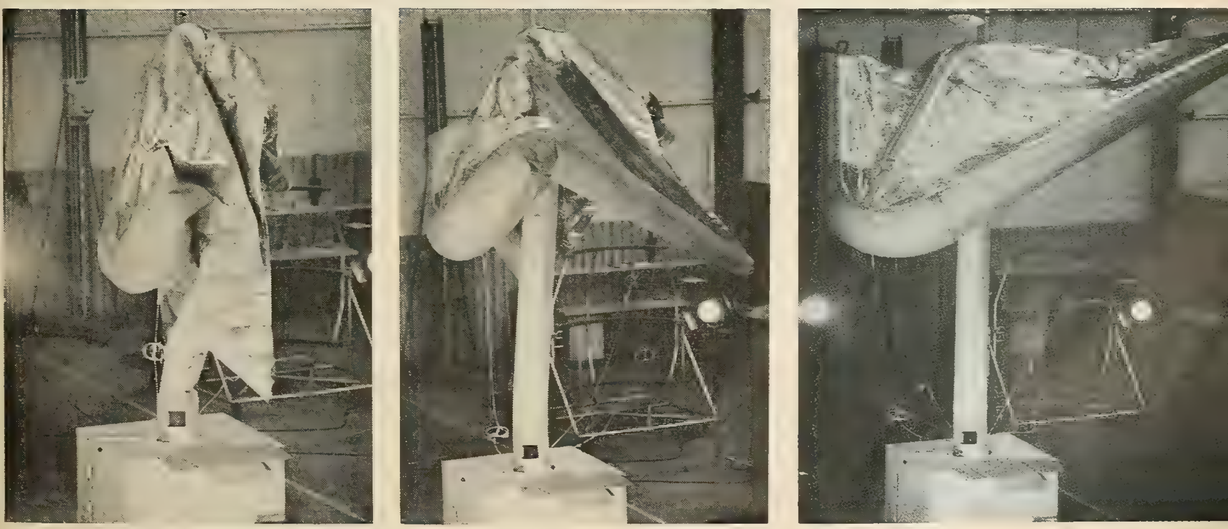
The higher altitude will also mean longer transmission time because it will be viewed for longer periods by U.S. and European ground stations.

The satellite is 34½ in. in diameter and weighs 175 lbs. Its speed will range from about 19,500 to about 8,400 mph.

Telstar II and its associated ground stations can transmit 600 voice channels, or one television signal, one way. The satellite can provide for only a limited number of two-way telephone conversations, but the ground stations' "multiplexing" equipment provides for only 12 one-way conversations at any one time.

Telstar II's telemetry will report on some 118 items each minute when it is commanded "on" by a ground station. *Telstar I* made 112 such reports. The principal additions include measurements of the command circuit and a more precise check on pressure inside the satellite.

It will be capable of sending its telemetry reports on the same microwave frequency (4080 mc) or VHF beacon (136 mc). ■



Exceeding specifications . . .

Air Force Defends Minuteman Program

Gerrity rebuts reports of missile's range, reliability and cost overrun problems

by Frank G. McGuire

THE AIR FORCE has rallied to the defense of its *Minuteman* ICBM program, following reports that the missile has had difficulties reaching its intended range, has had reliability problems, and has experienced cost overruns approaching a half-billion dollars.

Lt. Gen. T. P. Gerrity, Deputy Chief of Staff, Systems and Logistics, said the intercontinental ballistic missile is:

—Exceeding its Wing I design specifications of 5000-n.-mi. range by 100 miles.

—Exceeding it Wing II design specifications of 5500-n.-mi. range by an unspecified distance.

—Maintaining its development schedules "almost to the day"—despite the fact that the schedules were laid out three years ago.

—Operating on its development schedule "within the funds given by the Department of Defense."

—Carrying a much heavier payload and more penetration aids than called for in the original design, and carrying these at longer ranges than expected.

• **Wing I range**—At a Pentagon news conference called to air the Air Force's case, Gerrity said "We were faced with great urgency in 1959 to become operational as quickly as possible. We learned we could cut a year from the original *Minuteman* schedule pointing to 1963 by reducing certain performance capabilities. Let me hasten to add that these reductions in no way impaired our ability to reach selected targets. Wing I missiles have a range of 5750 statute or 5000 nautical miles. This betters the original specifications by more than a hundred miles."

Gerrity reported that the Wing II *Minuteman* range specification of 6300 statute or 5500 nautical miles is also being exceeded, but he declined to give the new figure.

• **Cost overruns**—Turning to a controversial aspect of *Minuteman*, Gen. Gerrity said emphatically:

"I can also state unequivocally that we are operating within the funds given by the Department of Defense."

The accuracy of this statement depends on the definition of a cost overrun.

Reluctant to use the nebulous words "cost overrun," Air Force spokesmen referred to a $400-million additional outlay for the strategic missile system and its sites as "program growth" based on engineering changes and similar shifts.

In the same general vein, a Defense Department statement said:

"The word 'overrun' means we are paying more for the same item. With *Minuteman*, this generally isn't so. In Fiscal Years 1963 and 1964, a cost increase of about one percent of our program can be attributed to pure 'overrun' or poor estimation of actual costs. The remainder of the fund problem was caused by four distinct items:

"First, changes in requirements, which raised development and production costs, but improved the flexibility and extended the survivability of the weapon.

"Second, problems we encountered in the test program and which required fast corrective action. We were programmed for success and had to pay for the fixes.

"Third, we shifted from an incrementally funded to a fully funded basis in FY '64.

"Fourth, we went through a Cuban crisis, and we put everything we had into putting *Minuteman* on alert during that crisis. After it was all over, we had to pay to get back on our test and installation schedules."

One AF spokesman estimated the true "overrun" portion of the $400 million (which was cited by Defense Secretary McNamara at Congressional hearings) as closer to 10%. This is at considerable variance with the DOD claim of 1%.

• **Definition of overrun**—According to DOD officials, there is no way to pin down the definition of an overrun—it is a much-misused word.

"It's a colloquial expression," said Howard J. Bordner, technical advisor to DOD Comptroller Charles Hitch. "Generally, it's whatever the additional cost may be, compared with original target costs or estimates. This may or may not include the cost of engineering changes, depending on the contract."

An Air Force official said there may have been some R&D overruns, under any definition, but there have been none in production contracts. He defined overrun in the latter instance as any contractor failure to meet target production costs. He added that the Air Force generally does not consider customer-requested engineering changes as cost overruns.

Gerrity, in discussing this point of engineering changes, told newsmen:

"When a weapon system is designed and a builder contracts to produce it, improvements are incorporated at an almost continuous pace. Obviously, any improvements we impose on our contractor must be paid for. While the original design meets all requirements, by the same token anything can be improved. The *Minuteman* of today is carrying a much heavier payload than the original design, plus additional penetration devices beyond the original design range."

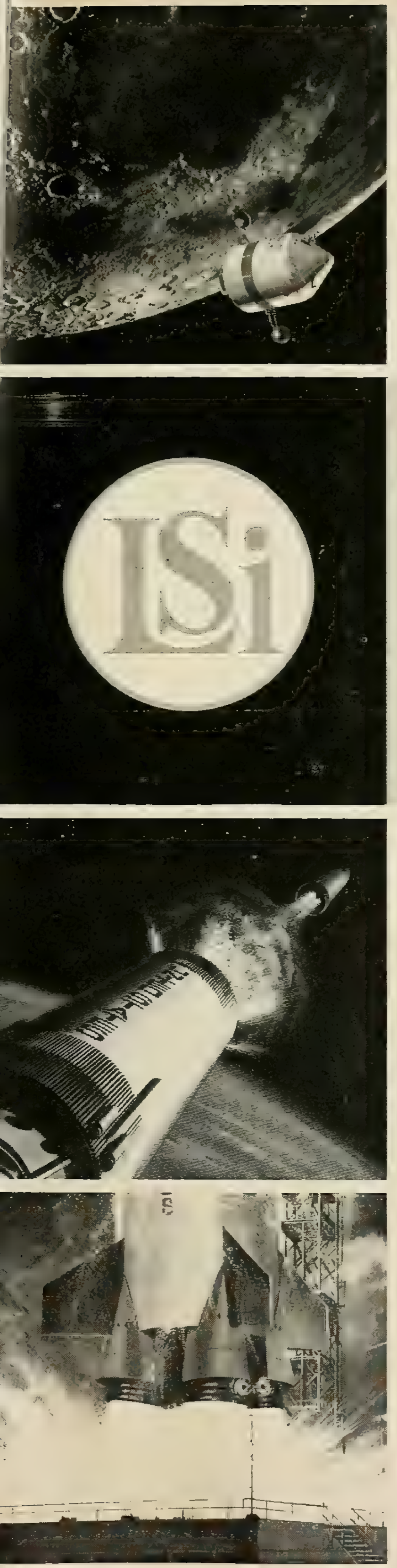
He declared that the test program for *Minuteman* has been and continues to be an outstanding success. Acknowledging a few R&D test failures, he said the causes of all of these have been located and eliminated.

• **Future plans**—Six wings of *Minutemen* are now planned, all of them to contain 150 missiles except the wing near Cheyenne, Wyo., which will have a total of 200.

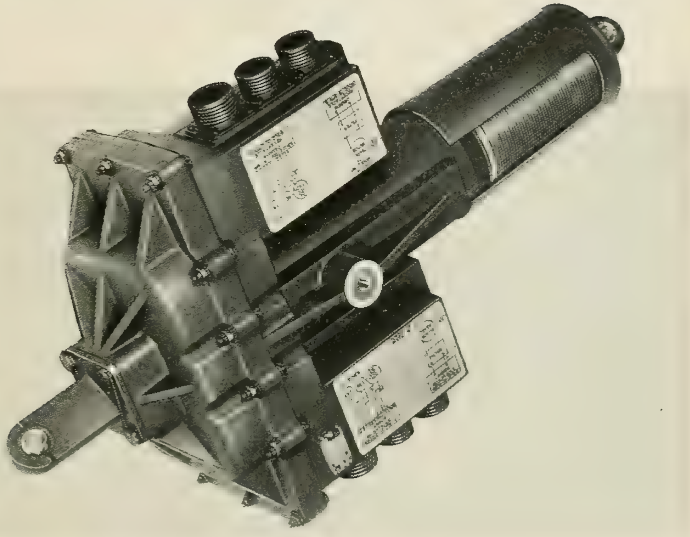
The missiles are designated as A, B and C versions, in order of their improvements. Earlier missiles operational at Malmstrom AFB, Mont., are A versions. Cheyenne will be equipped with the B version, as will three of the remaining four wings.

The sixth wing, at Grand Forks, N.D., will have the C version, considered a substantial improvement over the B in terms of range, payload and—especially—guidance. The sixth wing is expected to become operational late in Fiscal Year '64 (Calendar '65).

Comparing costs of the three missile versions, Gerrity said the moderately-improved B version is on a par with the A version, and the C version is slightly more expensive. He added, however, that simplification and improvement of ground support equipment will bring this portion of the system to an overall cost comparable to that of A and B.



ELECTRO-MECHANICAL SERVO ACTUATORS



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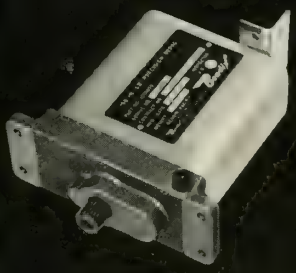

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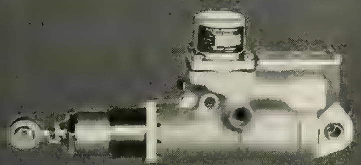

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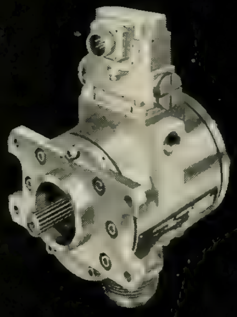

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Technical Countdown

ASTRONAUTICS

No Manual Override in Gemini Back-up Control

Gemini's Titan launch vehicle reportedly will yaw or pitch into a breakup attitude within one second of a control failure during that part of the flight it is subjected to maximum dynamic pressure because of the aerodynamic instability of the launch vehicle. To get immediate response to such a critical failure, the switch-over to back-up guidance and control has been taken out of the jurisdiction of the crew and made automatic. The automatic rate-switching level will be 4°/sec. during that part of the flight. After staging, aerodynamic instability should cease to be a problem and the limit will be opened up to 10°/sec. To further strengthen reliability, a complete dual-redundant control system will be used on the modified *Titan* booster.

Escape Plans Vary With Flight Phase

Emergency escape plans for *Gemini* crews call for use of escape seats only up to an altitude of 70,000 ft. Above that level, the spacecraft will be separated from the launch vehicle to complete an independent trajectory. Between 70,000 ft. and staging, this will be done by salvo-firing the retro-rockets. The top section of the adapter will be retained by the spacecraft to make it aerodynamically stable with its small end forward. It will be separated at the apogee of the escape trajectory for a blunt-end-forward re-entry. After staging, escape is performed by cutting off the booster and using rendezvous propulsion to effect separation.

ELECTRONICS

Trend From AC to DC Space Motors Possible

A prototype brushless dc electric motor has just been delivered to NASA's Goddard Space Flight Center by the Sperry Farragut division of Sperry Rand. Developed jointly by Sperry and NASA engineers for space use, designers expect an increase of 80% in electrical-to-mechanical power conversion efficiency. If the model meets design expectations, NASA officials predict a marked increase in use of dc over ac motors in spacecraft. To obviate the conventional brush and commutator assembly, a beam switching tube is used to direct an electron beam to 10 targets, each connected to a semiconductor switch. These, in turn, direct electrical power to proper motor coils. A variable-frequency oscillator sequentially directs the beam, and a photo-sensor is used for armature synchronization.

New Downrange Trackers Being Readied

The first Glotrac ground station has been sent to Grand Bahama Island for an interim checkout before being placed in operation. Two other stations are being integrated with the Azusa Mark II tracking system at Cape Canaveral. Other stations are to be located at Cherry Point, N.C.; Bermuda, Grand Turk, San Salvador and Antigua.

Re-entry Spectrograph Being Developed

To determine the spectral luminosity profile of re-entry vehicles, Armour Research Foundation is developing a multichannel spectrograph for on-board measurements. A part of the Defender program, the instrument development will permit a spectral film record to be made of a variety of points on a nose cone. The project is sponsored by the Air Force Cambridge Research Laboratories and ARPA.

New Injection Laser Operated

IBM Research Center scientists have operated an injection laser using indium phosphide, a semiconductor. (Only gallium arsenide and its related alloys had been previously used for such a laser.) Operating in the infrared range but at a different frequency, the success further strengthens current scientific belief that semiconductors will open the door to a very broad range of useful frequencies. Liquid nitrogen (77°K) cooling was used for pulsed operation; a continuous-wave output was achieved with liquid helium (4.2°K).

Advanced Telemetry Equipment Ordered

Radiation Inc., has been awarded two contracts totaling $3.5 million by North American Aviation for development of new telemetry systems for the *Apollo* and *Saturn* S-II stage program. Both systems will be completely computer-automated and will incorporate advanced design features to reduce operator error and increase processing speeds. Four major types of data will be converted into a single PCM format for recovery. A data-reduction subsystem will process that into forms for further computer analysis, viewing of oscillograph displays and quick editing of input data.

ADVANCED MATERIALS

Hydrazine To Be Produced in Reactor

Aerojet-General next September will demonstrate fissiochemical techniques for preparing hydrazine liquid rocket fuel. Experiments will be conducted at the Atomic Energy Commissions' Materials Testing Reactor at Idaho Falls, Idaho. The project, being performed under an Air Force contract, has drawn only raised eyebrows and expressions of doubt from AEC officials. Reason: cost (up to $150 million) is too high for developing the specialized nuclear reactor. Production potential, proponents say, could surpass reactor cost. In the experiment, a powdered uranium compound and liquid ammonia will be bombarded with neutrons. Uranium-atom fission is expected to convert ammonia molecules to hydrazine. The whole process is expected to be completed in less than one second.

Unique Liquid N_2 Control Probe Available

A system providing continuous automatic level control of liquid nitrogen is being produced by Cryogenics, Inc. Designed for use with self-pressurizing dewars, it also provides a supply-dewar alarm element. The new unit employs an upper-lower limit sensor. Located in a cold trap, it actuates a solenoid valve to control liquid transfer into the trap when the lower limit is reached. Liquid transfer is stopped at the upper limit. The warning system overrides transfer control when the self-pressurized dewar is empty.

Lower Helium Extraction Costs Possible

"Fifty percent or higher" cost reductions are possible in the extraction of helium from natural gas employing a new diffusion process developed by the Linde division of Union Carbide Corp. and now being offered for licensing. The process is based on selective permeability of helium through a thin plastic film. Key element is the permeation cell, consisting of a wire support screen within a paper envelope, all heat-sealed in a non-porous plastic membrane. The plastic is a special fluorocarbon copolymer. Permeation units are cascaded and outputs are sequentially re-compressed to increase helium concentration.

Charyk Details ComSat Corp. Future

Pacing factor may be international participation, not technical problems; Soviet cooperation invited

by William Beller

CREATION OF A COMMERCIAL communications satellite system may well depend on how soon international agreements will be reached rather than on the time it takes to solve the technical problems.

"We feel there should be only one commercial satellite system," Dr. Joseph V. Charyk, Communications Satellite Corp. (ComSat) president, told MISSILES AND ROCKETS in an exclusive interview. "What will take the time is getting all the countries to participate in such a system."

He observed, though, that countries will be spurred toward a single system by their need for good comunications.

If Russia wants to cooperate, "Fine! Wonderful!" he said. Noting that the Soviets could use their boosters to launch some of the satellites, Charyk said the ComSat Corp. would welcome this help. "It could be a real breakthrough in international relations."

Gen. A. N. Chizkov, Soviet Air Attaché in Washington, said he would welcome talks about the matter, but he would not indicate what he felt their outcome might be.

- **Industry stake in firm**—The role of U. S. industry in helping set up a commercial satellite system will start with the initial study contracts, which the corporation will put out for bids very soon. After this, Charyk said, industry will be asked to develop and fabricate the needed hardware.

The lists of invited bidders will be drawn up "with the advice and help of NASA as to who has the qualifications to do the work we're after," says Charyk. "We'll solicit the companies on these lists and ask them to propose."

The Federal Communications Commission will be watch-dogging the corporation to make sure procurements are on a competitive basis and that small business is dealt with fairly. This stricture is written into the act establishing the corporation, and gives the FCC a new type of responsibility.

On a strictly technical basis, the earliest the system could be operational is 1967. This figure assumes one year to complete the program definition phase and three years for the hardware phase. "This is a highly optimistic figure," says Charyk. He feels that 1969 is a more realistic time.

With a margin of safety, the program-definition phase will run between 12 and 18 months—up to the time of the initial stock offering.

"ComSat has a public as well as a business responsibility," Charyk pointed out, "therefore, before we go into the hardware stage, we want to be sure we move on the best judgment possible."

When the first stock offering is made, the ComSat Corp. will not necessarily have definitive international agreements but "at least we will have bounded the problem," he explained. The firm should know, for instance, how many countries might participate and what the agreements with these countries will probably be.

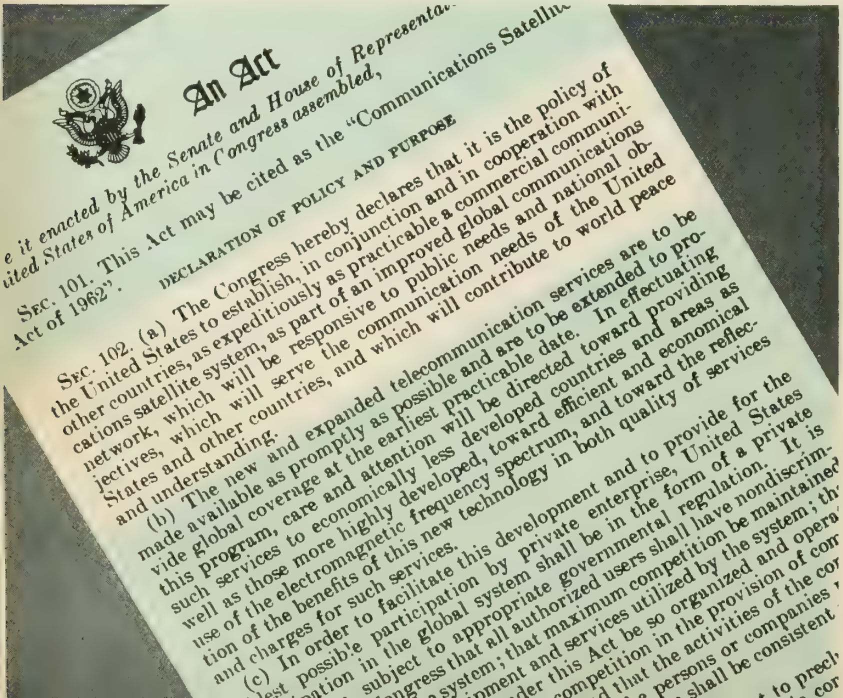
On the basis of these data, a pattern will emerge, ComSat will be able to gauge costs realistically, and the company will be able to tell the public the prospects for the stock they buy.

- **Corporation organization**—ComSat is dividing its work into two phases: Phase I—program definition phase—is to develop specifications for the minimum commercial satellite system that will still be highly attractive.

Phase II—after the stock offering—is to procure the hardware, test it, and train personnel.

For the first satellite system, all Phase II work will be done under contract. "Down the road we'll be doing in-house research," said Charyk, "and we may even find requirements for our own launch pads, which we might lease from NASA or DOD."

Although Phase I work will not be spectacular, "it will be the most important work we do because it will set the stage for all succeeding work," Charyk pointed out. In this phase the



An Act

e it enacted by the Senate and House of Representa-
ited States of America in Congress assembled,

Sec. 101. This Act may be cited as the "Communications Satelli
Act of 1962".

DECLARATION OF POLICY AND PURPOSE

Sec. 102. (a) The Congress hereby declares that it is the policy of
the United States to establish, in conjunction and in cooperation with
other countries, as expeditiously as practicable a commercial communi-
cations satellite system, as part of an improved global communications
network, which will be responsive to public needs and national ob-
jectives, which will serve the communication needs of the United
States and other countries, and which will contribute to world peace
and understanding.

(b) The new and expanded telecommunication services are to be
made available as promptly as possible and are to be extended to pro-
vide global coverage at the earliest practicable date. In effectuating
this program, care and attention will be directed toward providing
such services to economically less developed countries and areas as
well as those more highly developed, toward efficient and economical
use of the electromagnetic frequency spectrum, and toward the reflec-
tion of the benefits of this new technology in both quality of services
and charges for such services.

(c) In order to facilitate this development and to provide for the
lest possible participation by private enterprise, United States
pation in the global system shall be in the form of a private
subject to appropriate governmental regulation. It is
ongress that all authorized users shall have nondiscrim-
system; that maximum competition be maintained
ipment and services utilized by the system; th
der this Act be so organized and opera
competition in the provision of com
d that the activities of the co
persons or companies
shall be consistent
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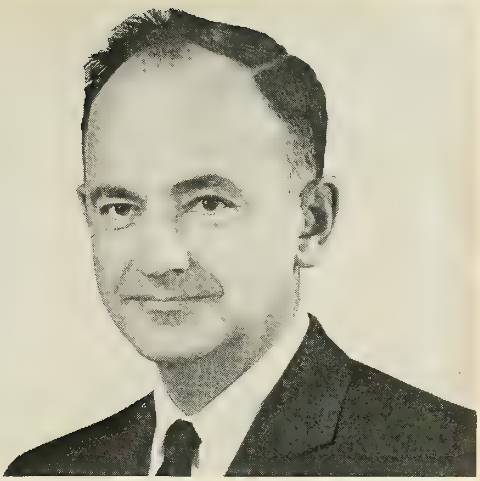
COMSAT Board Chairman Leo D. Welch



COMSAT President Joseph V. Charyk

corporation will undertake programs to:

—Determine what form the international organization will take.

—Determine what the system capabilities should be.

—Develop technical specifications for the system.

—Work up the test development plan.

—Formulate the financial requirements.

The organization of ComSat divides itself into five areas: international, technical, financial, legal, and public affairs.

• **International**—The total international communications system will be owned by the participating countries—or by businesses set up similar to the ComSat Corp. The U.S. company will probably hold the most stock.

ComSat has not yet made any overtures to any other country to develop communications satellite agreements. "We want to get a clearer picture of where we're going before we negotiate," Charyk said.

A problem ComSat faces is that in the various countries, the means of satellite communications could be owned by the government—or new entities may have to be created.

ComSat is therefore not sure what the final pattern of participation will look like. This is the reason the corporation wants at least a year to find out the wishes of other countries and then to use this information to help sketch the outline of the emerging satellite system.

• **Technical**—In its Phase I technical work, ComSat wants to know: (1) what areas have to be explored; and (2) what experiments have to be done. Out of this effort will come the data for Phase II.

The technical organization is made up of three elements: operations analysis, systems engineering, and project management.

The basic question asked in the operations analysis is how the system can be enhanced by tradeoffs. Would it be best, for instance, to choose a "random" system, which is made up of a number of simple active satellites in polar orbits of about 6,000 nautical miles altitude? Or should a system be chosen that calls for relatively complex, active satellites in equatorial orbits of about 19,300 nautical miles altitude—the "stationary" system?

The random system makes its greatest demands on the ground subsystem, according to a recent Rand Corp. study, while the stationary system makes its greatest demands on the orbiting subsystem. The random system, moreover, could be placed in operation sooner than a stationary system, but the stationary satellite concept appears to offer the greatest promise and growth potential.

The experimental work will be used to prove out the minimum system as well as to see the effects of selected tradeoffs. Part of the experimental work will call for prototype vehicles, which will be the first ComSat Corp. satellites sent into orbit.

The systems engineering element, meanwhile, will be drawing up the technical specifications and the detail design. Open space will be left at pertinent places in the design so that improvements that come out of the experimental work can be incorporated.

In this way, ComSat expects to ride the two horses of flexibility and frozen design.

The project management element is now being formed. "We're going after key people in this area, and very soon some names will emerge," Charyk promised. He emphasized that these people should be working on the project from the very beginning. They will be responsible for the development plans, schedules and costs.

• **Financial and legal**—The immediate financial problem is to determine how much money will be needed and how best to raise it. Part of this work will be to detail the elements entering into the initial stock offering.

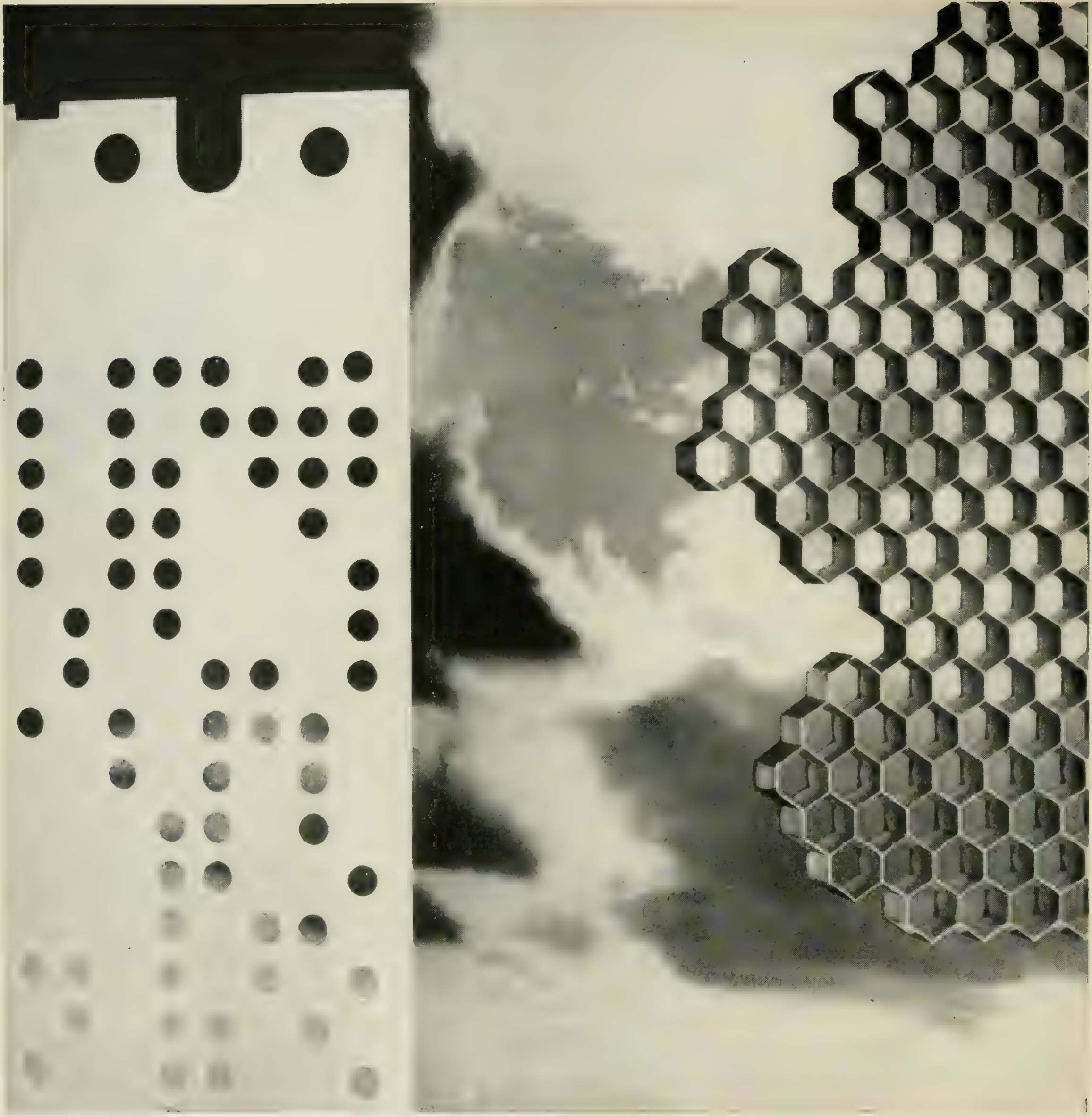
The most difficult problems will be faced by ComSat's general counsel, Charyk told M/R. He will be involved not only in the novel questions of international ownership of a complex entity but also in the equally unique questions of ComSat's relationship with the FCC.

Congress directed the FCC to "insure effective competition . . . in the procurement by the corporation and communications common carriers of apparatus, equipment, and services required for the establishment and operation of the communications satellite system and satellite terminal stations."

"Obviously, we must have considerable freedom to operate in order to get best results in a short time under good economic conditions," Charyk affirmed. "On the other hand, we can appreciate the need for regulation."

ComSat is trying to work out a balance with FCC. "We don't want procurement so odious that we can't move," said Charyk. This is a problem the legal counsel is studying.

Out of the ComSat's international discussions, in-house and contracted studies, a pattern is expected to be formed. In turn, the system's technical specifications will emerge. Development schedules and costs will be worked out. Based on these data, a prospectus will be written and the stock offering made. The hardware development phase then will begin. ■



Program for a mission, pattern for a launcher

Punched cards and aluminum honeycomb played an important part in the development of an advanced ECM simulator, and production of a lightweight launcher for ASROC. While the design problems were different, they were solved by a similar capability—engineering skill and ingenuity offered by Universal Match Corporation's Government Products Group.

A simple punched-card system provides a flexible method for programming the T-4 Electronics Countermeasures Simulator, developed by Reflectone Electronics, Inc., a UMC subsidiary: T-4 can duplicate virtually any RF condition which a B-52 ECM officer might encounter over enemy territory.

Engineers at UMC's Unidynamics Division combined light weight and high strength needed for ASROC's unique launcher through use of honeycombed aluminum. The unit not only nests eight missiles above deck, but also serves as launcher. This imaginative design technique points the way toward more reliable launchers of increased mobility.

UMC's Government Products Group offers the capability for solving many diverse problems, and the ability to design and produce advanced systems important to our defense posture.

UNIVERSAL MATCH CORPORATION
GOVERNMENT PRODUCTS GROUP

UNIDYNAMICS DIVISION
472 Paul Ave., St. Louis, Missouri

REFLECTONE ELECTRONICS, INC.
Stamford, Connecticut

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Central Information Source Urged

Aerospace Fluids and Lubrication conferees hear suggestion that reliability funds might better be spent on collation effort

by John F. Judge

San Antonio, Tex.—The lack of central coordination of data crucial to missile/space lubrication is so acute that new information-retrieval programs may provide rewards far greater than their dollar costs.

This prediction was made by R. E. Adams, director of advanced programs, General Dynamics/Fort Worth, at the recent U. S. Air Force 1963 Aerospace Fluids and Lubrication Conference here.

Addressing about 350 lubrication specialists, Adams urged that operations research techniques be applied to the field of lubrication research.

"Consider that today there exist 10^4 lubrication data curves useful to the designer," Adams said, "and assume a cost of $100 to collate and publish each curve in a fashion readily available to the designers. About $1 million would have to be spent on information retrieval under these assumptions."

But, said Adams, if this effort produced the data necessary to prevent only one space system failure, the dollar loss avoided could easily be in the $10-million range—a 10-to-1 payoff.

If this collation and publishing program resulted in saving 10 spacecraft component designs at a cost of $100,000 each (and Adams considers this a perfectly reasonable estimate) the payoff would not only equal the cost—but time also would be saved.

Adams suggested that funds now devoted to reliability be switched to cover the more fundamental problems, typified by lubrication research. Such a switch, he said, could eliminate the basic causes of unreliability.

- **Future research needs**—The GD planner cited three major areas in which lubrication research will be needed in the near future:

1) Physical characteristics of titanium, a metal destined for considerable use in certain missile/space applications, as well as in the supersonic transport field. Considerable challenge is offered by the study of titanium, which exhibits high friction and galling tendencies with sliding motions.

2) Large, rotating space stations in Earth orbit. Not only will the rotating surfaces be extremely large, but service-life requirements will have to extend over many months, says Adams.

3) Problems in lubrication research associated with interplanetary space probes. These probes will require reliable operations over periods of from three to five years.

The conference sessions included outlines of current and future development problems in solid lubricants, space-power lubrication systems, bearings, hydraulic fluids and greases. These presentations were made by spokesmen of the Air Force Aeronautical Systems Div., which sponsored the conference.

- **Solid-film needs**—Anticipated needs in solid-film lubricants, AF spokesmen said, are defined in terms of the operational environment. Temperatures will range from cryogenic to 2500°F.

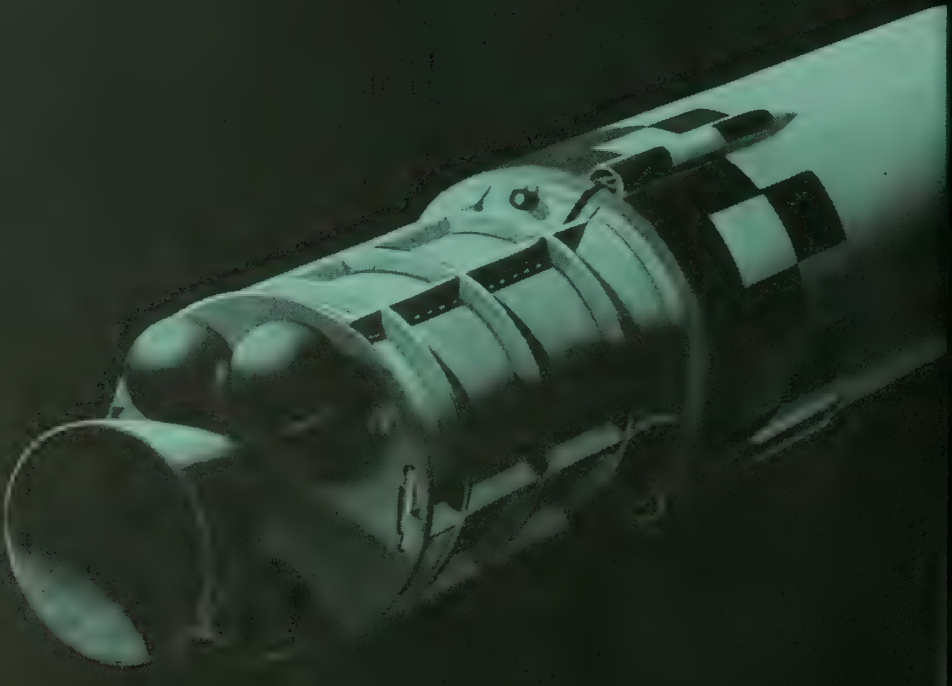
Loads can be expected from zero to above 200,000 psi. Life expectancy will increase from a few hundred hours to more than 30,000 hours. Pressures will range from atmospheric to interlunar (10^{-13}torr) and possible interplanetary (10^{-16}torr). Speeds will vary from a few revolutions per hour to well over 100,000 rpm.

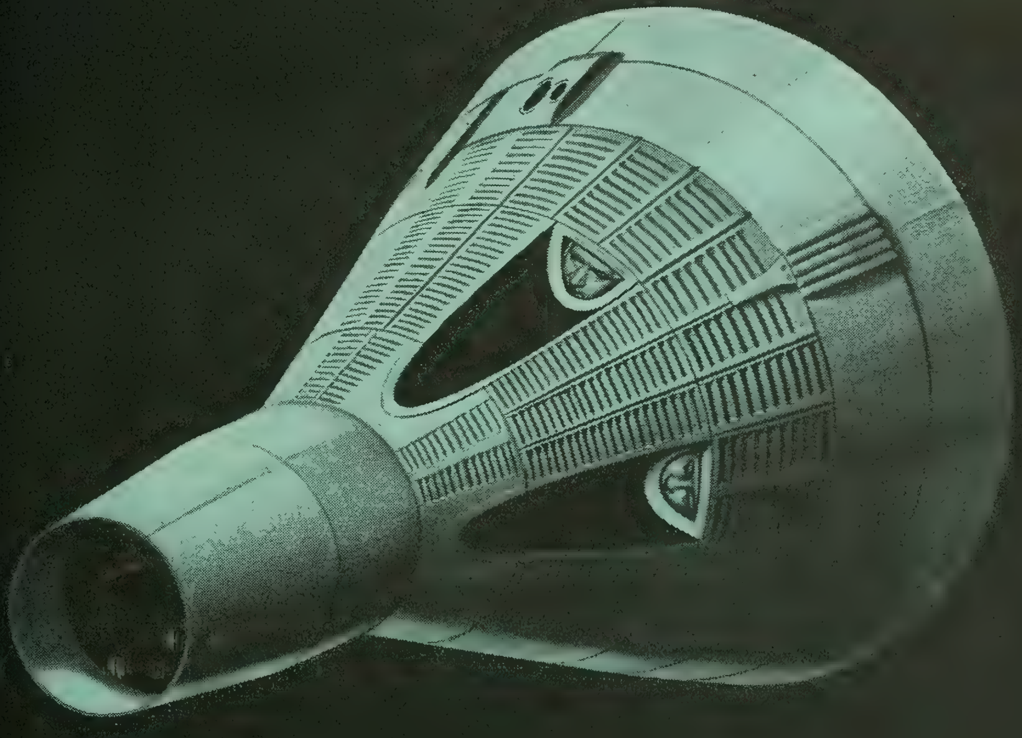
Current AF-sponsored research programs in this area include studies at Midwest Research Institute involving the basic crystal properties of solid lubricants. This investigation—concentrating primarily on single crystals of graphite—is aimed at achieving greater understanding of the basic lubrication

LUBRICATION APPROACH

LUBRICATION CONCEPTS	LUBRICANT CLASS	BEARING TYPE	TEMPERATURE RANGE °F	PRESSURE PSIA	SPEED LIMIT	LIFE (HRS)	RELIABILITY	LOAD CAPABILITY	AUXILIARIES
AUXILIARY SYSTEMS	Organic 1. Oils 2. High temp. grease 3. Polyphenyl ethers	Rolling element	(1.-3.) 200-600	6-15	7 x 10^5 dn	<10,000	Good	Medium	Seals & pumps
		Fluid film	(1. & 3.) 200-450	6-15	60,000 rpm	>10,000	Excellent	High	Seals & pumps
	Solid film 1. Gas entrained powder form 2. Rare metal coatings (gold-silver) 3. Self-contained	Rolling element	1. 200-1200 2. 200-700 3. 200-1000	1.-3. 10^{9} mm Hg to 15 psia	1. 7 x 10^5 dn 2. Oscillating 3. 7 x 10^5 dn	1.-3. <1000	1.-3. Poor	1.-3. Small	1. Seals & pumps 2. Seals & cooling 3. Seals & cooling
WORKING FLUID SYSTEMS	Liquid metal 1. Mercury 2. Sod. potassium 3. Potassium 4. Rubidium	Rolling element	(1.-4.) 250-600	6-15	<7 x 10^5 dn	<100	Very poor	Small	None
		Fluid film	(1.-4.) 250-1200	6-15	40,000 rpm	−10,000	Excellent	High	None
		Vapor	(1.-4.) 1000-2000	6-15	60,000 rpm	−10,000	Excellent	Medium	None
	Inert gas 1. CO_2 2. He 3. A 4. Ne	Rolling element	(1.-4.) 100-600	6-15	<7.5 x 10^5 dn	<100	Very poor	Small	None
		Gas	(1.-4.) 100-2000	6-15	−100,000 rpm	10,000+	Excellent	Medium	None

Switch-engine for Gemini: another job for Agena





In mid-1965, two astronauts—shown above in their Gemini capsule—will inch forward to dock with an Agena satellite. Project Gemini, sponsored by the National Aeronautics and Space Administration, promises a giant forward stride for the Man-in-Space program by using existing boosters to put separate components on orbit, there to be linked for the mission. The Lockheed-built Air Force Agena—now used in a wide variety of USAF and NASA programs—was chosen for Project Gemini because of the reliability and accuracy it has repeatedly demonstrated. The production-line Agena, so readily adaptable to a wide range of payloads, is giving maximum results for every space dollar.

Lockheed

Lockheed Missiles & Space Company, Sunnyvale, California • A Group Division of Lockheed Aircraft Corporation

mechanisms of lamellar solids, and at determining which of these mechanisms exercise influence over the lubricating properties of the materials studies.

These experiments are carried out in vacuums at the 10^{-13}-torr level and have consisted mainly of measuring the cohesive energy between layers of mica and graphite. The mica research is aimed at developing handling and mounting techniques for the small crystals, and at refinement of earlier data.

Data gathered to date indicate that the energy required to separate the layers in a vacuum is about 30 times the energy required. Such contaminating gases as helium, argon and nitrogen have no effect on this energy requirement, but water vapor pressure of 10^{-1}torr will cause rapid separation.

Additional tests are in progress with oxygen and hydrogen—after which the entire series will be repeated with graphite crystals. Preliminary studies with graphite indicate a separation energy greater than the yield strength of the crystal, and strengthening steps will have to be taken before cohesive energy measurements are made.

Another program—under way at the Ceramic Engineering Dept. of the University of Illinois—covers reactions, phase changes and other physical phenomena taking place in a ceramic-bonded, solid-film lubricant at various temperatures.

This work began with a study of the PbS-B_2O_3 system, which had excellent lubricating properties at 1000°F —but which dropped off sharply at 800°F. The study to date indicates that the binder plays a predominant role in the frictional behavior of the system.

Other systems using B_2O_3 as a binder now are under study to obtain new data on the part played by the binder. Such information will allow selection of materials with the specific properties needed to formulate superior high-temperature solid film lubricants.

A third program, just initiated by the Aeronautical Systems Division, is an effort to broaden the development of successful high-temperature solid-film lubricants over a wide range of environmental conditions. A number of different bonding approaches are being tried —vacuum deposition, flame spraying, and chemical bonding, as well as whatever other techniques may become available.

- **Space-power lubrication**—Lubrication is particularly critical in all of the proposed space-power systems—since, if anything does go wrong, it's usually the bearing system that fails, according to Pierce Angell, vice president and general manager of the Tapco Division of Thompson Ramo Wooldridge Inc.

Angell told the conference that the major requirements imposed on lubricating systems by space-power plants include: lifetimes of 10,000 hours or more; greater than 98% reliability; unattended operation in space; zero leakage; compatibility with system requirements on a minimum weight-to-power ratio; and capability to withstand shipping, launching and operational environments.

Two basic lubricant concepts in this area were cited by Angell: the auxiliary and the working-fluid systems. Though the auxiliary system introduces additional complexity into any space-power system, separate lubrication loops, using such fluids as the polyphenyl ethers, are under evaluation. But Angell says a great deal of work has yet to be done in verifying the compatibility of such fluids with nuclear radiation combined with relatively high temperatures and long-term operation.

Choice of the second concept, a working-fluid system, dictates the use of fluid-film bearings; and the current state of the art—both in liquid-metal-lubricated rolling-element bearings and in vapor-lubricated journal bearings—is inadequate for serious consideration of this system for existing space-power plants, says Angell.

Problems involved in selection of working fluid as the lubricating agency include turbulent flow, physical properties at elevated temperatures, and poor lubrication characteristics. Also to be achieved, in the application sense, is long life without maintenance—requiring bearings free of erosion, corrosion and cavitation. The low weight-ratio requirement can result in detrimental bearing structure compromises, and orbital operation imposes unusual steady-state and start-up conditions.

In outlining future bearing requirements, Kennerly H. Digges of ASD pointed out that control bearings must function precisely for the execution of critical maneuvers during periods of simultaneous maximum heating and loading.

For single-pass re-entry at superorbital velocity, Digges said, peak bearing temperatures in the 3000°F range are to be expected, with pressures ranging from atmospheric to vacuums in the 10^{-4}-torr range. But much higher vacuums in combination with high temperatures can be anticipated if the vehicle skips out of the atmosphere after initial penetration.

Other topics covered at the conference included: superconducting frictionless magnetic bearings; Air Force progress in grease research; gas bearings; and hydraulic fluid problems, with emphasis on high-temp applications. ■

Status of Liquid Metal Lubrication Research Directed Towards Space Power Conversion Systems[1]

LUBRICANT	INVESTIGATOR	SPECIFIC AREA	BEARING TYPE	SPEED RPM	TEMPERATURE °F	DURATION HRS.	UNI-DIRECTIONAL LOAD LBS.	STATUS
Hg	Thompson Ramo Wooldridge	SNAP 2	Hydrosphere	up to 40,000		2500	rotor mass	Achieved
Hg	Thompson Ramo Wooldridge	SNAP 2	Plain journal	up to 40,000		2300	rotor mass	Achieved
K	Sundstrand	General	Plain journal	up to 20,000	450		0-50	Achieved
K	Rocketdyne	General	Plain journal	up to 36,000	1000	500[2]		Achieved
K	ORNL	General	Plain journal	up to 4,500	800	75 start stop		Achieved
K	AiResearch	SPUR	Plain journal					In progress
Rb	Sundstrand	15KW Solar	Tilting Pad-Seal	28,000			54 Thrust 54 Radial	Run on Diphenyl
Li	Aerojet General	SPUR	Plain journal	3,000	Range 900-1200	17		stopped due to equipment failure
Water	General Electric	Stability	6 Studied	up to 35,000	100-160		0-200	In Progress
K	AiResearch	Vapor	Thrust	up to 60,000[3]	to 1800°F		to 150[3]	In Progress

[1] Omissions in data are due either to no requirement or to security restrictions.
[2] At 675°F and 27,000 rpm.
[3] Objective.

HIGHLIGHTING A KEY SEGMENT OF OPPORTUNITY FROM THE DIVERSE R&D PROGRAMS ALWAYS UNDERWAY AT ITT FEDERAL LABORATORIES . . .

EXTENDING THRESHOLDS IN SPACE

Utilizing space in long range communications is one of the major program areas at ITT Federal Laboratories. The work embraces research in the space sciences, generation and analysis of systems concepts, and the solution of specific technical problems in the development of earth/satellite communications systems for both military and commercial purposes.

SOME OF OUR GOALS AND TECHNIQUES:

Design of a global communication system through which many may communicate independently and simultaneously.

Phased array radio telescope antennas with 1,000 to 10,000 foot apertures.

All-solid state satellite-borne transponders.

High gain, directive phased array antennas for installation on unstable, uncontrolled satellites.

Transmitter designs utilizing solid state power supplies.

Ultra low noise parametric amplifiers.

Developing a lunar bounce communications link between ITTFL's fixed space communications station in Nutley, New Jersey, and an ITT terminal in England.

Exploring advanced modulation techniques for space applications, where the bandwidth restrictions affecting terrestrial systems do not apply.

Much of ITTFL's space communications work is contracted by NASA, the U.S. Army Signal Corps, the Air Force and other government agencies. A substantial portion, however, is company-funded. Three years ago ITTFL built its own radio telescope to further experimental investigations. Presently, the staff is participating with NASA in the RELAY program, using the ITT Nutley facility for satellite command and control, and as a ground terminal for a North and South America communications link. The South America terminal, a transportable ground station in Brazil, was also developed and built by ITTFL.

Your own interests in satellite communications, or any other area of information transfer systems, are probably well represented in this multi-laboratory organization. Your inquiry will receive a prompt and confidential reply.

IMMEDIATE OPENINGS IN THESE AREAS

Satellite Antenna Design ☐ Microwave Communication and Tracking System Design ☐ High Power Amplifier Design ☐ Engineering Analysis — Aerospace Systems ☐ Microwave Communication Equipment Development ☐ RF Circuit Design Engineering ☐ Solid State and Maser R&D ☐ Communication System Theory and Analysis.

To apply, or gain more information, forward your resume in full confidence to Mr. W. Bieszard, Box 77-WT.
ITT Federal Laboratories, 500 Washington Avenue, Nutley, New Jersey. (An Equal Opportunity Employer)

ITT FEDERAL LABORATORIES

HONEYWELL ADVANCED TECHNOLOGY REPORT NO. 3

How can research lead to improved

Battlefield of the future will be patrolled by passive influence fuzes that will trigger warheads by sensing specific circumstances such as (1) the pressure signatures of personnel entering the area, (2) the sound pattern or infrared radiated by a vehicle, and (3) disturbances of ambient magnetic fields by vehicles or personnel.

Operations analysis conserves R&D funding

Due to increased costs in developing ground weaponry, Honeywell has established an operations analysis capability that analyzes all facets of a weapon system design during the pre-development and development stages. This capability enables government agencies and Honeywell researchers to conserve R&D funds by determining the weapon systems needed, what their performance should be and how they can be used to best advantage.

Three major aspects of operations analysis are stressed at Honeywell:

1. REQUIREMENTS ANALYSIS determines which areas require new or improved weapons. Intelligence on enemy force structure, equipment, strategy and tactics is analyzed and recommendations for improvements or new weaponry made.

2. SYSTEMS OPERATIONS provides data on development and how the system is to be used. For example, target analyses identify tactical situations and define target types. Target vulnerability is defined. System cost and cost-effectiveness and weapon system vulnerability and/or survivability are also determined.

3. WEAPONS ANALYSIS establishes optimum values of design parameters on the basis of maximum system effectiveness. During the initial phase of a development program, for example, mathematical models for evaluating warhead and system effects are established and programmed. Working closely with design engineers, weapons analysis personnel evaluate a warhead and its components to determine effect on total system performance. Parametric studies are conducted to establish design trade-offs and to determine optimum system performance characteristics.

Future tanks will fire accurately while moving

The moment a tank stops to zero-in on a target, it may become vulnerable to enemy attack. This liability may be reduced by a new system being developed at Honeywell for the Army Tank Automotive Center. Currently in breadboard form, the Target Referenced Tank Gun Control System will allow a tank gunner to very accurately hold his gun sight on a *stationary* target while the tank is in motion. The tank gun is kept zeroed-in on the target by the use of gyros, accelerometers and an analog computer which provide the pitch, yaw and translations of the tank gun during the maneuvers. This information is used to automatically and continuously re-direct the gun and turret to the target. In addition, Honeywell is studying automatic tracking of a *moving* target by a moving tank.

ground warfare preparedness?

New weapons system concepts will result from government-industry advanced R&D

U.S. Army plans call for a significant modernization program during the next decade. The fiscal '64 Army budget proposed a substantial increase for research, development and procurement. If approved, this will make it possible for the Army to step up its pace in modernizing its ground warfare techniques and equipment.

Improvements in Army mobility, close air support of combat units, target tracking, stabilization and fire control, communications, command and control—all of these and others will result from the research and development effort.

A number of these new system concepts are now being studied by R&D groups at Honeywell (see examples below). Under funding from government agencies and our own independent development funds, Honeywell is investigating advanced concepts in the areas of missile systems, fuzing, warheads, guns, artillery, mines, bombs, stabilization and fire control, surveillance, communications and data handling, and training and simulation.

These programs are an indication of how the capabilities of industry can assist government laboratories and agencies in their activities toward improving the Army's combat effectiveness.

For more information on our research, experience and capabilities in ground warfare technology, write Honeywell, Dept. 671-M, Minneapolis 40, Minnesota.

Mathematics breakthrough leads to inertial fuze

An inertial fuze, several times more accurate than any other inertial fuze, has been devised by Honeywell for pinpoint detonation of a missile warhead. Less complex than a radar fuze, it is practically unaffected by vehicle and trajectory variations or atmospheric perturbations.

The Honeywell fuze, portions of which are currently in breadboard form, can be made virtually insensitive to nuclear radiation. Since it operates by sensing changes in the density of the atmosphere, it can be used on any warhead having a sufficiently high re-entry altitude.

The design of the inertial fuze was facilitated through the use of the adjoint analysis technique—a mathematical concept fashioned by Honeywell for use as an evaluation and design synthesis tool.

Needed was a combination of efficient and accurate simulation of a ballistic missile and its trajectory; the adjoint program was the breakthrough that produced such an evaluation in six degrees of freedom on a single computer run.

Laser range finder being developed by Honeywell under a company sponsored program will be mounted inside a tank as shown in this artist's conception. The pulsed ruby laser will be considerably smaller than present optical range finders.

Laser evolving as ranging device

Honeywell is developing a laser range finder for tank fire control and helicopter weapon systems. While similar to radar, the laser system has a beam less detectable by the enemy. It also reduces background clutter that often complicates battlefield ranging problems.

Both gaseous and solid state approaches are being studied, aiming at a range of at least 5,000 meters, data rate of ten bits per second and a total weight of 15 pounds. All of the engineering resources for development of such a laser are available at Honeywell.

Honeywell is also investigating improved laser materials, advanced techniques of pumping, possibilities of operating in new parts of the spectrum, and higher power in pulsed and continuous wave lasers.

Honeywell

ENGINEERS AND SCIENTISTS: Explore new professional opportunities. Write Mr. Fred L. Laing, Honeywell, Minneapolis 8, Minnesota.

Circle No. 10 on Subscriber Service Card

NASA Planning Mars Expedition

Scientists envision six-man, 400-day trip using chemical rockets; first subsystem study proposals are due May 20

by Warren Burkett

HOUSTON—NASA's Manned Spacecraft Center engineers are already planning a 400-day expedition to Mars for six astronauts and scientists as a logical step after the *Apollo* lunar landing program.

They believe that high-energy chemical rockets, rather than nuclear propulsion systems, offer the highest probability of success at the earliest possible date—sometime in the 1970's.

Full details of the plan will be presented May 21-23 at NASA's Lewis Research Center in Cleveland, when representatives from MSC, Ames Research Center and Langley Research Center gather for an in-house conference on the Mars expedition.

Meanwhile, plans for a modular Mars spacecraft were discussed here by D. M. Hammock, assistant chief of the spacecraft technology division at MSC.

The center has committed $250,000 for two design studies implementing the plan. Concepts were developed under Maxime Faget, associate director for research and development and originator of the *Mercury* spacecraft. Oscar Ohlsson is study project engineer.

- **Sequence**—Essential elements of the flight plan include:

—Assembly in Earth orbit of a three-module spacecraft with the required "propulsion packages" or rocket stages. The spacecraft resembles a high-thickness-ratio delta wing with a Mars Excursion Module riding piggy-back. Total weight in orbit, with fuel, comes to about 1.5 million lbs.

—Launch from Earth orbit and flight to the vicinity of Mars.

—Braking by grazing the Martian atmosphere. Spacecraft rockets would then be fired to produce a circular orbit about 300 miles above Mars' surface.

—Descent of MEM to the planet.

—Mars-orbit rendezvous, using an escape capsule cradled aboard the MEM, after the landing party spends about 40 days on the planet's surface. The MEM serves both as a shelter-laboratory and launching pad for the rendezvous capsule.

- **Three parts**—The modules were described as follows:

—*Earth Entry Module (EEM)*—A 15,000-lb. flying heat shield, resembling a "squashed cone," fitted at the apex of the triangular spacecraft. The center has allotted $150,000 for a design study protecting three crewmen and three passengers from heat generated by re-entry speed above 35,000 mph.

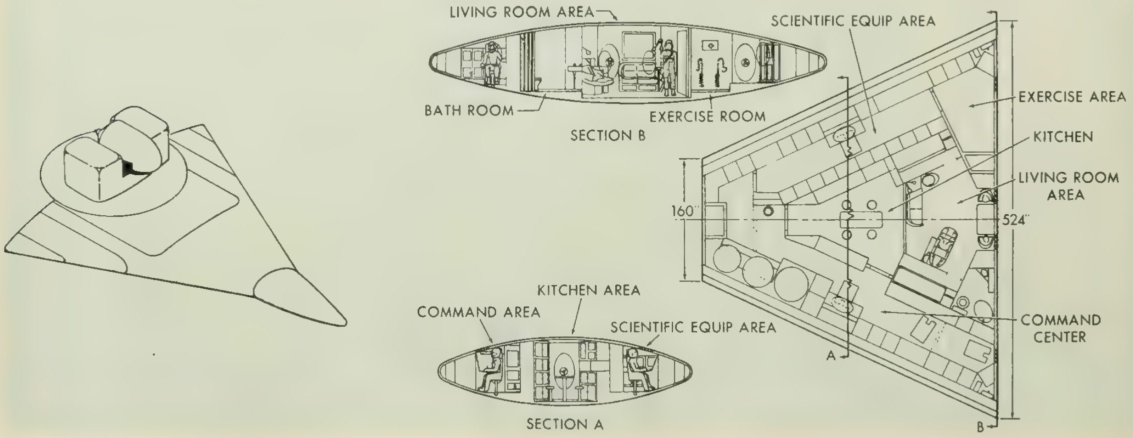
—*Mars Mission Module (MMM)*—A 30,000-lb. cabin for living, recreation, scientific, and control functions. A propulsion unit centered in the base of the triangle would stabilize the orbit and provide escape velocity. Artificial gravity would be furnished by mounting the propulsion unit on telescoping booms extendable 80 ft. from the cabin to produce about .4g.

Subsystem study proposals for the MMM are due May 20. The center has $100,000 budgeted for the study. The RFP specifies consideration of missions possible with the state of the art in the 1970-73 and 1973-78 periods. The RFP for the EEM calls for mission times in 1971, 1973, and 1975.

—*Mars Excursion Module (MEM)*—A 60,000-lb. combination of dish-shaped heat shield, cubic laboratory and shelter, and rendezvous rocket ship cradled atop the station. It rides piggy-back

(Continued on page 36)

ARTIST'S CONCEPT of three-module Mars expedition spacecraft is shown at left, details of Mission Module at right.



Systems Engineers...

some plain talk about ground floor openings at Honeywell

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Good systems men stay at Honeywell. We have one of the lowest professional turnover rates in the industry—less than half the national average. There are good reasons for it:

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Honeywell's Ordnance Division has grown fast—but steadily and carefully. We've doubled our size every 3 years since 1954. We're not an awkward young giant, or a one-contract wonder.

Our systems men will make major contributions to the continuation of this growth and they know it. What's more, management has committed itself to concrete support of this weapons systems group and its mission. The door is open to you, too, if you're qualified.

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That could mean a lot of things in different companies. At Honeywell, it means you're on your own. We hire a man to do a job, not to tell him how to do it. One of the strongest incentives you'd have is tough competition. It replaces the confining supervision you find in many companies.

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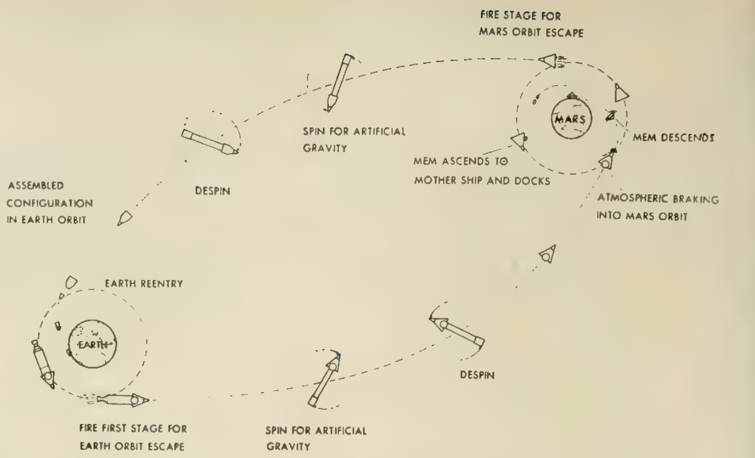
(Continued from page 34)



MISSION PROFILE for Mars expedition. After assembly in Earth orbit, craft would travel to Mars orbit; MEM would descend to Mars, then rendezvous for return to Earth.

over the MMM propulsion unit.

The full spacecraft will be about 70 ft. long, 50 ft. across the base of the triangle, 10 ft. thick at the highest point, narrowing to 5 ft. near the place where the MMM joins the Earth Entry Module. The outer tips of the triangle are composed of disposable fuel tankage.

"It can be assumed that the first complete system flight with all the modules will be an actual Mars space flight. The assurance of flight worthiness then becomes quite important," contractors were warned. Crewmen should be able to maintain any subsystem except where weight or time makes this impossible.

Hammock estimated the flight time to Mars at 100-120 days. The Mars landing time is limited to 40 days because a longer stay would make the fuel requirements to cover the increasing Mars-to-Earth distance too great. Return to Earth should take about 240 days.

• **National choice**—Development of a Mars program hinges on a public decision about the future directions of the national space program, Hammock said. NASA is conducting an agency-wide evaluation of the relative merits of space stations, permanent Moon bases, and a Mars expedition to follow *Apollo.*

Hammock said the technology needed for a Mars ship was simpler in many ways than that required for space stations or a lunar base. He cited some of the advantages:

—The only basic research critical to the mission is the heat shielding required for the Earth Entry Module, which would hit Earth's atmosphere at about 35,000 mph—10-15,000 ft./sec. greater than the *Apollo* re-entry velocity. The center has specified that the EEM be capable of entering without performing a retro-fire maneuver.

—Most of the spacecraft can be constructed with conventional materials. The Mars Mission Module in particular,

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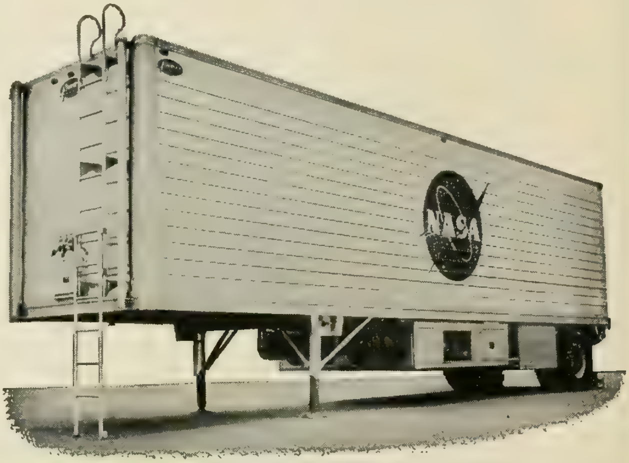
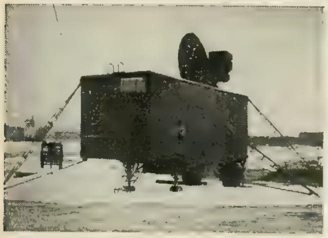


This insulated, air-conditioned trailer was built by Dorsey for General Electric Company's Missile and Space Vehicle Department to house checkout equipment for the Nimbus space craft.



Dorsey built this special trailer for Raytheon Company to house the Army's new AN-MPS-34 mobile weather radar.

One of the Navy's new automatic carrier landing systems is contained in Dorseys like this, built for Bell Aerosystems Co.

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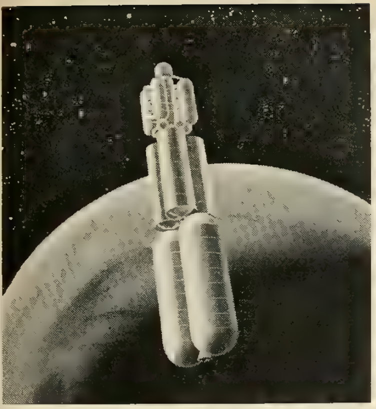

EMPIRE Ship in Mars Orbit

DRAWING shows vehicle convoy concept of an EMPIRE (Early Manned Planetary-Interplanetary Round-trip Experiment) in orbit around Mars. Concept was reported by General Dynamics/Astronautics' Krafft Ehricke at recent AIAA meeting in Dallas.

Hammock said, could be built of aluminum. Center specifications call for the subsystems to be composed of "off-the-shelf" items, principally those developed from the *Apollo* program.

—Launch into orbit can be achieved with *Saturn V* rockets already under development. The study estimates that four *Saturn V* rockets would be needed. The complete modular spacecraft would constitute one payload, followed by another *Saturn V* carrying a small propulsion unit and a tanker of fuel. Two more *Saturns* with fueled propulsion packages would complete the spacecraft-rocket assembly.

—The mission could be accomplished relatively soon, due to use of tested chemical rocket techniques. It would be unnecessary to wait for nuclear rockets to reach the same state of reliability and safety of operation.

—Mission peculiarities, resulting from the reduced gravity and thinner atmosphere of Mars, reduce the orbit, entry, and rendezvous speeds and propulsion requirements. The more tenuous atmosphere of Mars reduces the heat-shielding requirement for the Mars Excursion Module to the current state of the art: thin metal and insulation, similar to that of the *Mercury* capsule, will suffice to protect the men.

—Life support on Mars will be comparatively simple, because of the presence of all the elements of human life (although in vastly smaller amounts than on Earth). Life support systems on the MEM can be reduced to equipment that concentrates and enriches gaseous mixtures drawn from the Martian atmosphere. ■

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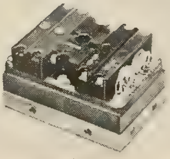

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UAC Cyborg Study in Second Phase

Artificial organisms, drugs, hypothermia under investigation as techniques to extend man's physiological capabilities in space

by Heather M. David

WINDSOR LOCKS, CONN.—A NASA-contracted study that will have far-reaching effects on the design of man-machines for space is going into its second phase at United Aircraft Corp.

Called the cyborg study, the research project is considered by many to be the most exotic of bioastronautic subjects.

The term cyborg, a contraction of cybernetics and organism, implies the biological study of man and the techniques by which his abilities could be extended: artificial organisms, drugs, or hypothermia. These means were studied for feasibility in spaceflight use by the Biosciences and Technology Department of Hamilton Standard's Space and Life Systems Department.

A NASA contract with the Office of Advanced Research and Technology's Biotechnology and Human Engineering Department covers:

- **Biocybernetics**—According to cyborg project director Robert Driscoll, this portion provides for the development—from a physiological standpoint—of electrical analog and physical dynamic models of human systems and subsystems.

The object of this development—which stresses mathematical models—is to aid in generating predictions about how the human cardiovascular system will function under partial weightlessness. The researchers hope eventually to construct an analog which can be used with various simulators to study the effects of prolonged weightlessness and subsequent re-entry.

The Biosciences group will move soon into a new laboratory at Windsor Locks as part of a management transfer from United Aircraft Corporate Systems Center to its Hamilton Standard Division. The new quarters will have extensive animal research facilities and its staff will be able to do primate experiments to verify results of computer simulations.

In addition to the cardiovascular system, mathematical models will be developed for the central nervous system, pulmonary function, endocrine system and mineral dynamics.

Artificial organs have also been investigated. These could be used as non-restricted study subjects and they may also yield data applicable to the extension of man's capabilities, researchers say.

The United Aircraft group has been working on an experimental heart device (see photo) to study the engineering aspects of flow turbulence and pressure characteristics of the heart-pump and valve assembly.

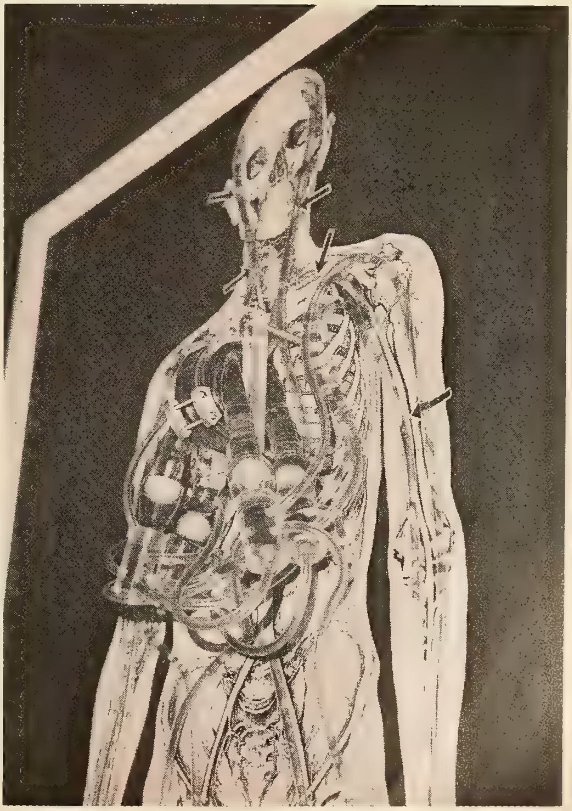
The group eventually hopes to build a dynamic model of the human cardiovascular system to learn more about its physiology under altered environments.

- **Mineral dynamics**—Reports that one of the latest Russian astronauts suffered an unexpected calcium mobilization (loss in urine) during the second and third day after exposure to weightlessness have made the field of mineral dynamics a critical one to bioastronautics specialists.

Advanced projects chief Dick Allen said the Biosciences group will study by mathematical analysis and experiments the entire problem of how the weightless body handles minerals.

- **Hypothermia**—A prime objective of the cyborg study has been to investigate means of reducing space life-support systems requirements.

The Biosciences group is currently studying how nutrition and critical min-



EXPERIMENTAL heart device in use at United Aircraft.

ENGINEERS & SCIENTISTS: IMMEDIATE OPENINGS IN INERTIAL GUIDANCE

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is smaller than this page.

One of the world's smallest, lightest weight inertial platforms, it is only one of many projects now under development at General Precision Aerospace. Long a leader in inertial guidance systems – the first inertial guidance system was developed in 1949 and the first flight test followed in 1954 – General Precision Aerospace is today one of a handful of companies in the nation with full in-house capability to design, develop and provide systems management for complete celestial inertial guidance and control systems. ☐ Talented engineers are needed now to actively participate in a wide range of inertial guidance programs...men who can rapidly move up to Task and Project Management positions. Fast paced activities range from instrumentation systems for re-entry vehicles...to advanced marine and avionic guidance...to accelerated flight test programs on MMRBM (Mobile Mid-Range Ballistic Missile)...to new, hybrid stellar inertial guidance systems. ☐ There are immediate openings for: SYSTEMS SYNTHESIS — SR. ANALYSTS ☐ ANALOG PROGRAMMERS ☐ ELECTRO-OPTICAL SYSTEMS ENGINEERS ☐ MISSILE FLIGHT CONTROL ENGINEERS — ADAPTIVE/OPTIMAL ☐ ADVANCED PROGRAMS — PROGRAM MANAGERS & SR. STAFF ENGINEERS ☐ GUIDANCE & NAVIGATION SYSTEMS — PROJECT ENGINEERS ☐ FLIGHT TEST ANALYSIS & PLANNING — PROJECT ENGINEERS ☐ TELEMETRY — SYSTEMS — PROJECT ENGINEERS ☐ RELIABILITY & QUALITY ASSURANCE. A formal resume is not required; just tell us briefly about your current work and special interests. We will contact you promptly. Write to Paul Kull, General Precision Aerospace, Little Falls, N. J. Dept. 13E

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*Miniature Inertial Navigation System — featuring one of the smallest, lightest weight inertial grade platforms today. The true dimensions are 8.975" x 7.407" x 7.385", less than this page, though printing limitations make it impossible to show the silhouette in actual size. It weighs 14.5 pounds with 4 gimbals, 3 inertial grade gyros and 3 accelerometers—displacing less than ½ cubic foot of space. Now under extensive flight testing, this platform features a rapid warm-up capability—fully operational in 5 minutes from –65° F.

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erals are affected by a space environment. Later, it proposes to try to determine nutritional requirements under conditions of weightlessness, high and supergravitational states, and hypometabolism. In conjunction with this, biorhythms and sleep-wake cycles have been proposed for investigation.

While hypothermia (lowered temperatures) will not be emphasized in the near future, some conclusions have been drawn about the feasibility of using drugs or freezing to produce hypometabolism.

Drugs acting upon the hypothalamus or pituitary glands may be the most effective means of reducing body temperatures to hypometabolic states, United researchers say. However, further study is needed to produce a nontoxic and consistently acting drug. The scientists say research into the effects of the different lower temperature levels would be very useful.

One drawback of deep hypothermia is that the subject may need artificial cardiovascular and kidney systems to maintain life.

A study of hypothermia for space travel may result in vast terrestrial medical fallout.

- **Sensory deprivation**—Since normal human reaction to isolation and lack of stimuli is a limiting factor, some way must be found to gauge the effects of sensory deprivation, and to aid the isolated space traveler.

Some experiments at the basic nerve cell level already under way in the Biosciences group will have possible application to the cyborg work. Under the direction of James Casby, a method of monitoring traffic on a nerve was devised by exposing a tibial nerve of a cat and introducing electrodes.

Basic stimuli and their effect on the nerve were studied, including hair, press, touch, tapping, pin prick, clamping and burning. Casby's group also is simulating the effects of weightlessness on nerve behavior by removing the nerve's "endplates," and making it behave as though it were weightless.

UAC's ultimate objective is to determine quantitative requirements for maintaining optimum mental status during long flights. Bioinstrumentation will be used to study what signs appear when subjects become inattentive or bored.

Eventually, the group will draw up design requirements for devices to be used as substitutes for normal stimuli—by recorded noises, visual cues, tasks, and tactile stimuli.

United Aircraft Corp. signed the original eight-month cyborg contract with NASA Aug. 15, 1962. In future work, the company proposes to concentrate on the areas of sensory deprivation, mineral dynamics and mathematical models. ■

Instrumentation Planning Engineers

Tomorrow's "birds" at the Atlantic Missile Range will require sophisticated new range instrumentation systems to measure their performance. Insuring that the Range can meet the data acquisition, data handling, and data support requirements of each new launch in the next five years is the responsibility of Range Planning Engineers with Pan Am's Guided Missiles Range Division.

Their assignment . . . to plan a range which can support Titan III, Gemini, Apollo, and scores of future programs . . . makes demands on all areas of technology. Operational analysis, computer systems, celestial mechanics, CW and pulse radar, optics, communications, underwater sound, ship instrumentation, meteorology, logistics, range safety are just a few of the disciplines involved in their programs.

And, these programs are diverse. For example, plans are under way for:

• simultaneous range support for time-critical complex missions.
• increasing the accuracy of pulse and CW radar systems through ultraprecise and near-real-time calibration using satellites.
• the use of instrumentation satellites to escape from the effects of the earth and its atmosphere.
• the integration into the Cape Canaveral complex of a new Central Control Operation, to handle the increased scope of orbital and space missions.

Experienced Engineers interested in joining this effort are invited to write Dr. Charles Carroll, Dept. 56E2.

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Decision-Making: Hostile or not Hostile?

A few years ago this decision was relatively simple. The action that followed was relatively simple. Today the consequences of this type of decision-making can be enormous, affecting world-wide forces and events. The decision itself may trigger an incredibly complex series of interacting decisions and controls. In making these compressed-time decisions, commanders use man-machine systems which provide information processing assistance. The development of these large systems is the work of scientists, engineers and computer programmers at System Development Corporation. The system is their concern, not the actual design of hardware. Specifically, they contribute in these key areas: defining the requirements of the system, synthesizing the system, instructing the computers within the system, training the system, evaluating the system. Throughout they seek to optimize man-computer relationships and to develop a system which grows and changes with the needs of the decision-makers who use it. Human factors scientists, operations research scientists, systems-oriented engineers and computer programmers interested in joining a close interdisciplinary effort are invited to write concerning new positions in this expanding field. Address Dr. H. C. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C., Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."

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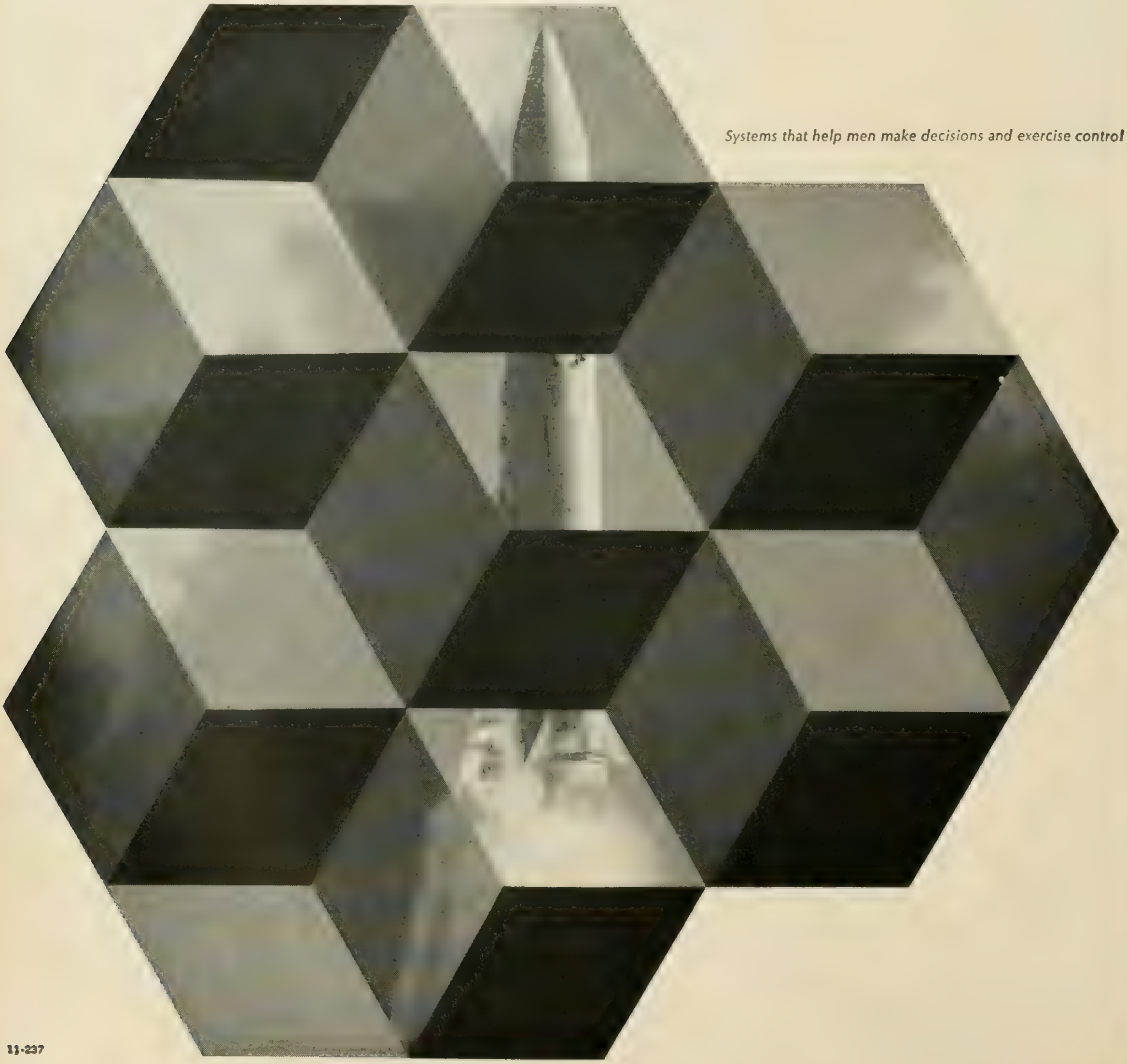

Systems that help men make decisions and exercise control

11-237

Martin Buys into Sperry Rand

Martin Marietta Corp. has confirmed its purchase of approximately one million shares of Sperry Rand Corp. common stock. Martin has declined to give a reason for the move, but there has been speculation recently that Martin might take over Sperry Rand.

Confirmation of the purchase came shortly after Martin Marietta President George M. Bunker was elected to the Sperry Rand Board of directors.

New Firms and Divisions

General Electric's Flight Propulsion Div. has established an Advanced Engine and Technology Dept. at Evendale, Ohio. The new department will assume work formerly done by the Flight Propulsion Laboratory Dept., which has been discontinued. Facilities, personnel and resources of FPLD will be transferred to the new department. . . . *Handy & Harman, New York City, has changed the name of its Norristown, Pa., stainless steel tubing subsidiary from Posen & Kline Tube Co., Inc., to Handy & Harman Tube Co., Inc. H & H makes capillary and bourdon tubes for guided missiles, aircraft and electronics applications.*

Industry Facilities

Terminal-Hudson Electronics, Inc., New York City-based distributor of electronic parts and components, has leased a new building in Orlando, Fla., to serve as an initial warehouse and distribution facility for a new Florida industrial sales division of the company. The company presently has other distribution centers in New York City and Los Angeles. . . . *B. F. Goodrich Aerospace and Defense Products has completed a new 40,000-sq.-ft. plant in Akron, Ohio, for development and manufacture of glass filament-wound rocket motor cases. In addition to a manufacturing area, the facility includes a materials control laboratory and engineering and production offices.* . . . Computer Products, Inc., Belmar, N.J., has added 6,000 sq. ft. of manufacturing space to its facilities. CP manufactures analog computers for government and industry. . . . *The Johns Hopkins University has added an office and laboratory building to its Clarksville, Md., Applied Physics Laboratory. The new 70,000-sq.-ft. building will house the Space Development Div., Fleet Systems Div. and other research activities.* . . . North American Aviation, Inc., Columbus, Ohio, has completed a 23,000-sq.-ft. thermodynamics lab to test missile and aircraft fuselage sections, systems and other components at simulated high altitudes. The new $2.5M lab can simulate air pressures up to 120,000 ft. and temperatures from −70 to 900°F. . . . *The U.S. Army Corps of Engineers has officially announced the opening of its Canaveral District office at Merritt Island, Fla. It is the first district to be organized for missile/space construction only.* . . . Hexcel Products, Inc., Berkeley, Calif., manufacturer of aluminum honeycomb for missile/space applications, has opened a new plant in Irving, Tex. The new facility aims at serving the aerospace industry in the Southwest. . . . *Lockheed Missiles and Space Co., Sunnyvale, Calif., has begun construction on a quarter-million-dollar facility for testing the effects of liquid hydrogen. The facility will be located at Lockheed's test base in the Santa Cruz Mountains on San Francisco Peninsula.* . . . The Navy has announced tentative plans to rebuild Allegany Ballistics Laboratory facilities at Rocketer Center, W. Va. Before it was destroyed by a recent fire, the Rocketer Center facility was engaged in work on Navy missile programs.

Representatives Named

Howard J. Schuft, Inc., Newtonville, Mass., has been named New England area representative for Cubic Corp., San Diego, Calif., missile/space electronics manufacturer. Schuft maintains a branch office in New Haven, Conn. . . . *Ralph N. Conner, Berkeley, and Robert Nordstrom, Whittier, have been named northern and southern California representatives of Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., manufacturer of data acquisition and processing equipment.* . . . Gerald Rosen Co., Inc., Natick, Mass., has been appointed New England representative for Huggins Laboratories, Inc., of Sunnyvale, Calif. Rosen is to represent the Huggins line of traveling-wave tubes and instruments/subsystems products. . . . *Schwartzschild Assoc., San Francisco, has been appointed exclusive northern California representative for Nesco Instruments Div. of Datapulse Inc., manufacturer of chart recorders for industrial and laboratory use. Nesco headquarters are in Inglewood, Calif.* . . . The Thatcher Equipment Co., New York City and Florham Park, N.J., has been named Metropolitan New York and northern New Jersey representative for Lucifer Furnaces, Inc. . . . *R&D Electronics Supply Co., Inc., Cambridge, Mass., has been named Maine-Vermont-Massachusetts-New Hampshire distributor for National Transistor, Lawrence, Mass., subsidiary of ITT. R&D is to carry the complete line of National silicon and germanium miniature computer diodes, silicon rectifiers, selenium rectifiers, silicon zener diodes and diode modules.* . . . Scott's, Hamilton, Ont., has been named Canadian representative of SAMES USA, Inc., a U.S. subsidiary of the French electronics firm, Société Anonyme de Machines Electrostatiques. Scott's will be primarily responsible for marketing the firm's electrostatic spray gun used in application of dry powders, plastics, enamels, silicones, and ceramics on a variety of metal, textile, and wood surfaces.

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contracts and procurements

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$9,500,000—**General Precision, Inc.**, Little Falls, N.J., for continued research and development on the dual stellar inertial guidance system envisioned for the *MMRBM*.

$4,400,000—**General Electric Co.**, Philadelphia, for *Titan II* re-entry vehicle work.

$3,600,000—**North American Aviation, Inc., Space and Information Systems Div.**, Downey, Calif., for *Hound Dog* weapon system production.

$3,387,000—**General Motors Corp., AC Spark Plug Div.**, Milwaukee, Wis., for research and development for the *Titan II* guidance system (supplemental contract).

$3,300,000—**Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for work on missile programs.

$2,450,000—**Massachusetts Institute of Technology**, Cambridge, Mass., for performance of research and development in the application of improved inertial navigation techniques and instrumentation to ballistic missile guidance and control systems.

$2,216,270—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for production of *Thor* space boosters (supplemental contract).

$2,000,000—**Radio Corp., of America**, Camden, N.J., for work on communications and tracking subsystem for the X-20 (*Dyna-Soar*) system.

$2,000,000—**General Motors Corp.**, Milwaukee, Wis., for *Titan II* guidance system components.

$1,800,000—**Avco Corp.**, Wilmington, Mass., for machine tools, laboratory and testing equipment.

$1,400,000—**Avco Corp.**, Wilmington, Mass., for work on a classified project.

$1,337,985—**General Dynamics Corp., Astronautics Div.**, San Diego, Calif., for production of equipment, spare parts, tools and test equipment for the installation and checkout of *Atlas* missiles.

$1,100,000—**North American Aviation, Inc.**, Downey, Calif., for acquisition of machine tools, laboratory and test equipment.

$1,000,000—**Hughes Aircraft Co.**, Culver City, Calif., for test equipment for *Minuteman* and *Titan* missile guidance system components.

$1,000,000—**Minneapolis-Honeywell Regulator Co.**, St. Petersburg, Fla., for continued research, development, technology and engineering on primary guidance system for the X-20 (*Dyna-Soar*) missile system.

$1,000,000—**Radio Corp. of America**, Burlington, Mass., for research on components for space application.

$250,000—**Space General Corp.**, El Monte, Calif., for design, fabrication and testing structural components for a manned space station escape paraglider.

Electronic Communications, Inc., Research Div., St. Petersburg, Fla., for a research and development program related to electronic control of laser beams (undisclosed amount).

General Electric Co., Syracuse, N.Y., for *Titan* missile guidance and control equipment (undisclosed amount).

ARMY

$5,379,008—**General Dynamics Corp.**, Pomona, Calif., Div., for research and development on the *Redeye* program.

$2,850,000—**Hughes Aircraft Co.**, Culver City, Calif., for continued research and development on the *TOW* system.

$2,200,000—**Intercontinental Manufacturing Co.**, Garland, Tex., for *Pershing* missile motor cases.

$1,900,000—**Sperry Rand Corp., Sperry Utah Div.**, Salt Lake City, Utah, for engineering services for the *Sergeant* missile.

$1,700,000—**Joy Manufacturing Co.**, Michigan City, Ind., for production of air compressors.

$1,500,000—**Raytheon Co.**, Lexington, Mass., for component production to support NATO-*Hawk* missile program.

$1,100,000—**North American Aviation, Inc.**, Downey, Calif., for *Hawk* missile components.

$1,072,414—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for metal parts for the *Honest John* rocket.

$1,000,000—**Hayes International Corp.**, Birmingham, Ala., for production of modification kits for *Pershing* missile trainers.

$99,000—**Radio Corp. of America**, Camden, N.J., for research leading to development of a thermoelectric power module of advanced design.

NAVY

$1,700,000—**Raytheon Co.**, Bedford, Mass., for *Sparrow III* missile services and studies.

$1,500,000—**Martin Marietta Corp.**, Orlando, Fla., for *Bullpup* missile guidance system transmitters.

Cryo-Therm, Inc., Fogelsville, Pa., for *Mark II* guidance system shipping containers (undisclosed amount).

NASA

$1,200,000—**Chrysler Corp.**, Michoud, La., for modifications to the *Saturn* booster facility.

$825,900—**William J. Graham and Son**, Houston, Tex., for facilities support at the Manned Spacecraft Center.

$425,000—**Radio Corp. of America**, New York City, for production of solar cells for *Nimbus* meteorological satellite at Mountaintop, Pa.

$218,000—**American Machine & Foundry Co., Advanced Products Group, Field Operations & Engineering Div.**, New York City, for modification of pneumatic and electrical systems at *Saturn* launch complex 34 at Cape Canaveral to accommodate future models of the *Saturn* space booster.

$67,800—**National Beryllia Corp.**, Haskell, N.J., for a study of improved beryllium oxide materials for microelectronics technology.

$45,500—**Martin Co.**, Denver Div., for a study of effects of solid-propellant rocket exhausts on launching facilities.

Hydraulic Research and Manufacturing Co., Burbank, Calif., for the development and production of electrohydraulic thrust-vector-control actuators for gimbaling F-1 engines on the S-IC stage of the *Saturn* space vehicle (undisclosed amount).

Electronic Communications, Inc., St. Petersburg, Fla., for production of 8 model-3 *Saturn* flight-control computers.

INDUSTRY

$7,500,000—**FMC Corp., Ordnance Div.**, San Jose, Calif., from the **Boeing Co.**, for missile suspension and alignment system for the *Minuteman* missile system.

$5,600,000—**Amphenol-Borg Electronics Corp., Amphenol Connector Div.**, Chicago, from **North American Aviation's Autonetics Div.**, for *Minuteman* electrical interstage connectors and harness assemblies.

$3,500,000—**Radiation, Inc.**, Melbourne, Fla., from **North American Aviation's Space and Information Systems Div.**, for automatic telemetry data processing systems for *Saturn* and *Apollo* S-II stage programs.

$796,000—**Beckman Instruments, Inc.**, Fullerton, Calif., from the **Boeing Co.**, for two telemetry data systems to be used in development of the X-20 (*Dyna-Soar*) and *Minuteman* ICBM programs.

$403,000—**Schulz Tool and Manufacturing Co.**, San Gabriel, Calif., from the **Boeing Co.**, for cryogenic quick disconnect coupling assemblies for liquid hydrogen transfer to be used on X-20 (*Dyna-Soar*) launch equipment.

$400,000—**American Machine & Foundry Co.**, New York City, from **Urbahn-Roberts-Seelye-Moran**, for work on door machinery, platforms and vehicle handling systems for the *Saturn* vertical assembly building at Cape Canaveral.

$400,000—**Scientific Data Systems**, Santa Monica, Calif., from the **Boeing Co.**, for a space simulator control system.

$231,000—**Radiation, Inc.**, Melbourne, Fla., from **Martin/Orlando**, for computer high-speed strip printer.

$186,000—**McCormick Selph Associates**, Hollister, Calif., from **North American Aviation's Rocketdyne Div.**, for production of electro-explosive safe/arm initiators for solid propellant rocket motor.

$85,000—**Lukens Steel Co.**, Coatesville, Pa., from the **Boeing Co.**, for components for the *Minuteman* missile.

Informatics, Inc., Culver City, Calif., from **JPL's Deep Space Instrumentation Facility** network, for provision of computer programs (undisclosed amount).

Hercules Powder Co., Wilmington, Del., from **Martin/Orlando**, for development of *Sprint* anti-ICBM terminal point-to-point missile propulsion system (undisclosed amount).

Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., from the **Marquardt Corp.**, for a digital data-acquisition system to be used to test the reaction-control motor for the *Apollo* vehicle (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

U.S. Army Missile Command
Procurement and Production
Special Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXDA

Selected source procurement with Barnes Engineering Co., Stamford, Calif., for systems engineering and pedestal and van modification for *Black Knight* re-entry physics program. This requirement is synopsized only for the purposes of affording subcontracting opportunities through direct inquiry with the prime contractor.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Instrument, tensile testing, suitable for testing the physical properties of solid-propellant rocket fuels complete with accessories and chart paper. IFB L-3496. Bid opening 5-27-63.

National Aeronautics and Space Administration
Headquarters: Procurement Branch
Washington 25, D.C.

NASA is negotiating a contract with General Telephone and Electronics Laboratories, Bayside, N.Y., for investigation of a precision high deflection rate laser beam steering device. This notice for information only.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

NASA solicits proposal for a requirement for a contractor to furnish engineering services for study, design, fabrication and testing of cryogenic service systems for large liquid-fueled space vehicles. Contract is for a period of one year with option to extend for two additional one-year periods. Require 18,000 hours engineering services in Huntsville, Ala., 14,000 hours plant engineering and miscellaneous fabrication and testing services. RFP Q-47-3. RFP due date 5-27-63. Contact Mr. Byron Driskill, Cocoa Beach, Fla., 783-8132.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with the Minneapolis-Honeywell Regulator Co., Cleveland, for two oscillograph accessories and various vanometers. RFP C-107202. Note: For information only. No RFP available.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with Industrial Electronic Service Co. for Thermocouple averaging system—1 each. RFP C-4229. Note: For information only. No RFP available.

Negotiations will be conducted with Computer Products Inc., 1717 F St., South Belmar, N.J., for various equipment to expand the CPI Mark III analog computer. RFP C-43080. Note: For information only. No RFP available.

Martin Denver—as integration systems contractor for the TITAN III multiple use booster—has a vital responsibility in

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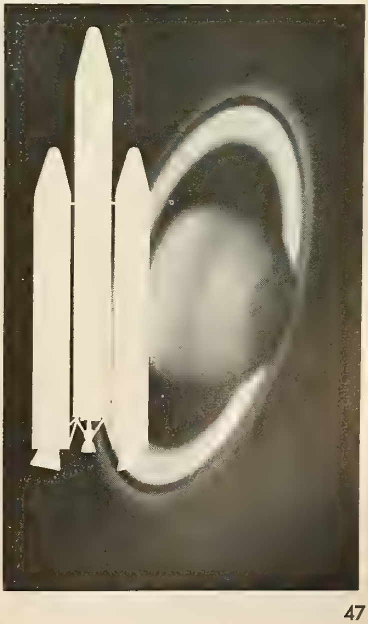
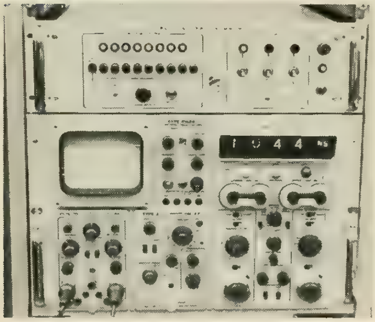


New Product of the Week: Readout Scope Programmer



A programmer designed to extend the usefulness of dual-trace digital readout oscilloscopes in automatic measurement applications is being marketed by Tektronix, Inc.

The programmer, Type 262, is said to offer simplicity of programming, compatibility with automatic measurement systems, and sufficient flexibility to accommodate auxiliary equipment and future system requirements.

Eight program cards are used, each of which can be set up to measure parameters such as amplitude, time, start-to-stop time intervals, commands from various percents of A or B signals of either polarity, or first or second pulse selection. Upper- and lower-limit digital comparators can also be programmed on the cards.

The sequence of measurements can be automatic or on a manual selection basis via pushbutton control. Two or more programmers can be connected to provide up to 16, 24 or more programs per test sequence. Additionally, Tektronix says, one can select the number of programs in automatic sequence; it is not necessary to sequence through all programs, if only a few are desired.

Circle No. 225 on Subscriber Service Card

Radiography Machine

A lightweight radiography machine has been put on the market by the Instruments Div. of The Budd Company.

Principal advantage claimed for the Iriditron Model 100 is that it offers high capacity (100 curies) yet weighs only 37 lbs. The lightness of the unit results from using spent uranium as shielding for the iridium 192 source.

The control, source tube and source itself are interchangeable with any other Budd Iriditron radiography unit.

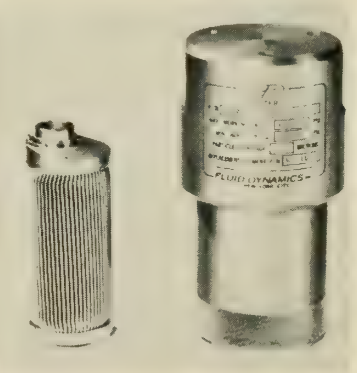
Circle No. 226 on Subscriber Service Card

Ultrahigh Vacuum Pump

A pump developed specifically for ultrahigh vacuum is being marketed by Mt. Vernon Research Company. The pump is designed to solve the problems of baking, gasketing, oil degradation, back-streaming, contamination by the forevacuum, cryopumping and bakeable feedthrough ports.

Model 1810 is all stainless steel with a flange 18 in. O.D. and height of 38 in., including the integral cryopump and trap. It is said to provide 19,000 liters/sec of cryopumping and 1,600 liters/sec of permanent gas speed at the flange. A pressure of 5 x 10^{-10} torr can be achieved with minimum operator techniques using metal gaskets.

Circle No. 227 on Subscriber Service Card



6000-PSI Filter

An all-stainless-steel "Tee" type filter for service to 6000 psi is being marketed by Fluid Dynamics, Inc. Featuring a high-collapse strength pleated element of all-welded construction, the new unit is offered in 2, 5, 10 and 40 micron nominal ratings.

Standard sizes are ¼ through ¾ in., with connections in either female AN or FNPT.

Two models are offered, one with Buna N seals and the other with Teflon seals. The latter, Model FR2, is rated for service with N_2O_4 and other highly reactive fluids.

Circle No. 228 on Subscriber Service Card

Ion Beam Generator

The Ion Beam Generator, a development of CBS Laboratories, is said to provide steady, controllable beams of metal ions. It is designed for applications in semiconductor technology, image formation and research.

The unit operates on the principle of surface ionization, and can emit steady ion currents as high as 10 microamperes for many hours. Vacuum requirement is less than 5 x 10^{-5} torr. The Ion Beam Generator claims high efficiencies: 100% ionization with lithium, sodium, potassium, rubidium and cesium; 55%, 84% and 44%, respectively, with gallium, indium and thallium. The unit measures 4½ x 4½ x 4½ inches.

Circle No. 229 on Subscriber Service Card

Solid-State Limit Switch

A limit switch, designed to trigger at a precise predetermined level, actuating an internal solid-state relay and a self-contained DPDT electromechanical relay, is being marketed by Airpax Electronics, Inc. The triggering level is set by a screwdriver adjustment accessible from the top. Resolution of this level is 1 μa over a range of zero to 1.15 ma.

A second screwdriver adjustment, also accessible from the top, sets the differential between pick-up and drop-out levels. This adjusts the hysteresis loop width in the solid-state amplifier.

Circle No. 230 on Subscriber Service Card

Pressure Measuring System

A pressure measuring system designed to eliminate the need for cumbersome conditioning equipment and costly power supplies is available from International Resistance Company's Control Components Division.

The potentiometer-type pressure transducer unit uses conventional 115-volt, 60-cps power for input; its output signal feeds a remote control panel meter. The complete system has only two components.

Available in 16 standard models, covering pressure ranges from 0-6 to 0-5000 psig., the system is said to have an accuracy of 2%; hysteresis, linearity and resolution each within 0.5%.

Circle No. 231 on Subscriber Service Card

Vacuum Gauge

A Model 700 cold cathode gauge with a Model 710 stainless steel gauge tube to monitor vacuum pressures in production operations ranging from 25 microns to 10^{-7} torr, is being marketed by Vactek, Inc., a subsidiary of Geophysics Corporation of America.

The Model 710 is a cold cathode discharge gauge tube designed for production type applications that experience pressure "bursts." It can be rapidly outgassed by baking up to 450°C for precise vacuum measurement.

The Model 710 tube can be supplied with step seals for glass-to-metal joints, and is adaptable to any type of flange or fitting. It is equipped with a magnet of field strength 1150 gauss.

Circle No. 232 on Subscriber Service Card

Microwave Switches

Three new switches for use with low power radio frequencies are being marketed by the Westinghouse Electronic Tube Div. Small size, rugged construction, reliable operation, and long life are claimed for the units. No direct-current bias is required.

The WX-5329 switch features a switching speed of one nanosecond. It is for operation at frequencies in the C band, and it has an isolation rating of as high as 40 db.

A broad band of frequency is featured on another switch, the WX-5385. It is designed for operation between 1.7 gc and 5.5 gc, a switching speed of 10 nanoseconds and a minimum isolation rating of 23 db.

The third switch, the WX-5080, features high isolation—80 db min. Its frequency range is 5.4 to 5.9 gc, and it has a switching speed of 40 nanoseconds.

All of the switches are equipped with type TNC connectors, but other connectors are available on special order.

Circle No. 233 on Subscriber Service Card

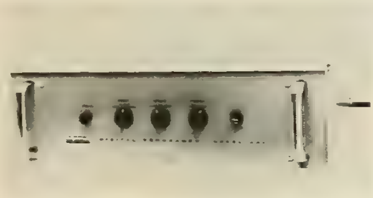
Full Ku-Band Attenuator

E & M Laboratories is marketing two new Ku-band attenuators. The Model Ku102 VA is reported to cover the entire Ku-band, from 12.4 to 18.0 gc, with a maximum VSWR of 1.35 and an attenuation that can be varied from 1.2 to 20 db. The Model Ku103 VA is indicative of the type characteristics attainable over a narrow bandwidth. This unit covers the 14.0 to 16.0 gc frequency band with a maximum VSWR of 1.25 and an attenuation that can be varied from 1.0 to 25 db. Both units are designed in UG-419/U waveguide, are 3¼ in. long, and weigh approximately 10 oz. The dc-resistance of each attenuator is approximately 30 ohms, and less than 200 ma of drive current is required to achieve the specified characteristics.

Circle No. 234 on Subscriber Service Card

Digital Programmer

Cohu Electronics, Inc., Kin Tel Div., has developed the Model 441 Digital Programer, designed to command parallel-input digital devices in response to serial information read from punched tape or other digital storage media.



Panel controls are designed to give the operator single point, automatic, or externally commanded progression options. Internal shift register and storage provides 8 decades BCD capacity.

Circle No. 235 on Subscriber Service Card

Piezoelectric Accelerometers

A complete line of piezoelectric accelerometers plus all the associated electronics has been added to Cubic Corp. products.

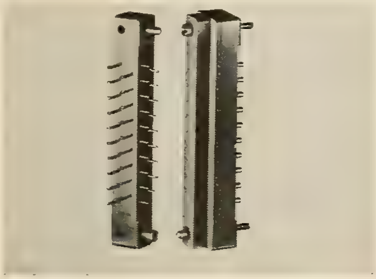
Four basic accelerometers are said to have been developed, including one of the smallest ever made, to be used in medical research. The electronics firm reports it will also make custom designs of the acceleration measuring devices to customer specifications.

Circle No. 236 on Subscriber Service Card

Plug and Socket Connector

A right angle plug and socket connector for printed circuit board applications is being marketed by Continental Connector Corp.

Designated Series 683-40 and 683-41, the special unit features 19 solderless wrap plug terminations and 38 taper pin socket terminations. Each wire-wrap termination has two taper receptacles in common when the connector is mated.



Contact spacing is staggered and has a center-to-center dimension of 0.250 in. Guide pins and guide sockets are polarized to prevent improper mating of plug and socket.

Body material is glass reinforced Diallyl Phthalate Type GDI-30 per MIL-M-19833. Pin contacts are brass and socket contacts spring temper phospher bronze, both with gold on silver plate.

Circle No. 237 on Subscriber Service Card

Camera Processor Projector

A six-second, high-resolution camera processor projector for electronic display systems has been developed by OPTOmechanisms, Inc., Plainview, New York.

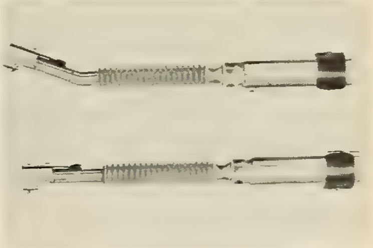
The rapid film processor is designed for use in the acquisition and display of data to provide a permanent, fully processed photographic record of the event under study seconds after it has taken place.

The equipment operates automatically, requiring no operator attendance beyond film and chemical loading. The total time required to record and project a picture, including film exposure, development, fixing and washing, is said to be 6 to 8 seconds.

Circle No. 238 on Subscriber Service Card

Angle Handpieces

Foredom Electric Co., Inc., is marketing Right Angle Handpiece No. 56 and Contra Angle Handpiece No. 55, designed for use with all Foredom miniature power tools. The angle handpieces, similar to dentists' drills, are designed for reaching difficult and otherwise inaccessible places. Possible uses suggested are in the electronics and instrument fields, and in metalworking, plastics, ceramics.



Circle No. 239 on Subscriber Service Card

Trimmer Potentiometer

Daystrom, Inc., has available a subminiature trimmer potentiometer. Resistance range of the new Model 515 is from 10 ohm to 50K over an operating temperature range of from −55°C to 150°C. Power rating is 1 watt at 55°C.

Circle No. 240 on Subscriber Service Card

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FOR RESEARCH, DEFENSE,
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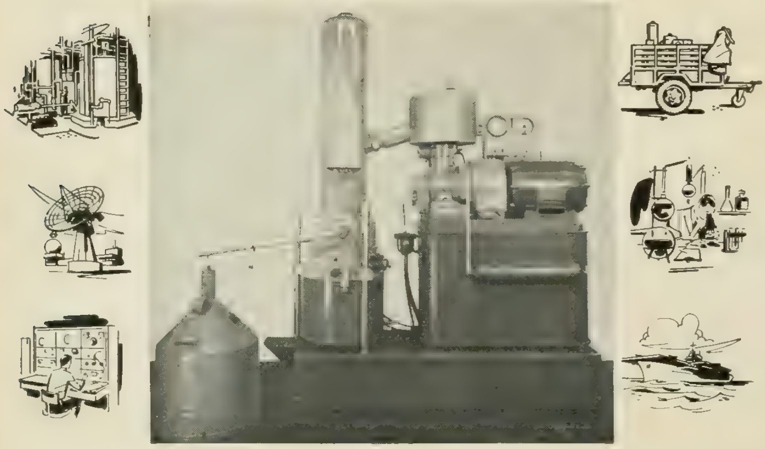

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Circle No. 17 on Subscriber Service Card

Document Handling Unit

A new line of products and services for handling documents recorded in miniature on film has been developed by International Business Machines Corporation. The IBM Micro-Processing equipment was demonstrated at the National Microfilm Association convention in San Francisco.

The new equipment is designed to bring together two major information-handling techniques: the storing of documents on microfilm and the ability to maintain and search files of documents quickly with data processing equipment.

Circle No. 241 on Subscriber Service Card

Precision Attenuators

A series of direct reading precision attenuators to provide accurate variable attenuation over a frequency range of 2.60 to 40.0 gc in eight standard models is being marketed by Waveline, Inc. The attenuators provide a variable attenuation of 0 to 60 db over the full waveguide operating frequency range which is indicated directly on an accurately calibrated scale.

The units provide varying attenuation values that depend on mathematical law and are independent of frequency.

Circle No. 242 on Subscriber Service Card

High-Voltage Power Supply

Calibration Standards Corporation, a subsidiary of Royal Industries, Inc., is producing a 0-10, 010vdc, 0-15 ma high voltage power supply that incorporates an 18,000-volt pass tube to permit its being cycled on and off at full output voltage. Features include line regulation of 0.002% for a 10% change in line voltage; load regulation of 0.005% from no load to full load; ripple of 1 mv rms any polarity; output setting or load; stability of 0.005%/hour, 0.03%/day; and accuracy of 0.25%, 1 kv and up.

Circle No. 243 on Subscriber Service Card

Portable Test Wattmeters

A portable wattmeter (Model PY-5) designed for general laboratory and field testing of panel and switchboard instruments is being marketed by the Westinghouse Scientific Equipment Department.

The self-contained instrument is offered in double-voltage and single-current ranges, as well as double-voltage and double-current ranges. It is rated for direct current and for 20 through 135 cps alternating current. The instrument can be operated continuously at 50% above rated voltage.

Circle No. 244 on Subscriber Service Card

Miniature Solenoids

MagneTec Corporation, Canoga Park, Calif., has designed and is manufacturing a group of miniature solenoids to be added to their line of electromagnetic equipment.

Known as the Series 1614, the miniature solenoids are push type general purpose units, for use on data processing equipment, valves, switches, latching mechanisms, printers and servo applications.

A unique feature claimed for the solenoid is the method of suspending the armature to eliminate sliding friction. This results in faster actuating and return time and eliminates wear of the armature against side walls. Plunger stroke is adjustable to extremely close tolerances.

Circle No. 245 on Subscriber Service Card

new literature

LAB TEST EQUIPMENT—A 16-page catalog describing the complete Houston Instrument line of X-Y recorders, T-Y recorders and laboratory test equipment is offered by the firm. The catalog provides technical descriptions of all instruments. Houston Instrument manufactures ac and dc voltmeters, dc amplifiers, ac/dc converters, log frequency/dc converters, and test calibrate units.

Circle No. 200 on Subscriber Service Card

DATA ON TRIMMING POT—A technical data sheet has been published on Daystrom 510 Series Transitrim trimming potentiometers. It provides complete specifications covering the transistor-size adjustable potentiometers. The 510 Series is designed to provide the engineer with a trimming potentiometer in TO-5 can configuration and bare wire leads for automatic printed circuit board assembly.

Circle No. 201 on Subscriber Service Card

INSTRUMENT CATALOG—Abrams Instrument Corp. is offering a catalog of intervalometers, timing and programing controls, and solid-state time delay relays manufactured by the company. The catalog illustrates a variety of standard models, plus basic units for custom modification. Technical data, outline dimensions, and environmental qualifications are given.

Circle No. 202 on Subscriber Service Card

MICROWAVE COMPONENT CATALOG—An illustrated, 24-page catalog 12-H devoted to microwave components has been issued by Microlab. The catalog includes descriptions, specifications and illustrations of standardized microwave components.

Circle No. 203 on Subscriber Service Card

PROBLEM: *Design an aircraft for tactical battlefield support in unprepared areas, under all weather conditions.*

SOLUTION: *Chance Vought's XC-142A V/STOL transport under development for the Army, Navy and Air Force. Designed for versatility, the tilt-wing craft has vertical take-off capabilities and will cruise 200 to 300 nautical miles with a full military load of 32 troops or 8000-pound payload at speeds of 250 to 300 knots.*

The tri-service XC-142A is just one of the many fascinating programs now being investigated by Chance Vought engineers and scientists. Perfecting ideas is a daily assignment at Vought, and to do the job right, the best technical talents are needed. Engineers and scientists who qualify will be given professionally stimulating responsibilities in fields such as: ***DYNAMICS*** Flutter and vibration, acoustic and vibrational environments, control dynamics, fluid mechanics and stress analysis. ***AERODYNAMICS*** Aircraft, missile or launch vehicle configuration design, stability and control, airloads and aerodynamic heating. ***STRUCTURES*** Stress or fatigue analysis, redundant structure analysis, loads and structural development. ***OPERATIONS ANALYSIS*** Assignments in mission analysis, operation requirements of space systems, systems evaluation and comparison, mathematical models and simulation studies, cost analysis and long range technical planning. ***AVIONICS AND INSTRUMENTATION*** Experience in one of the following specializations required: electronic circuit design, flight test electronic instrumentation, electrical or electro-mechanical control systems analysis or GSE missile electronics. ■ If you're looking for a company where your opinion counts in creative problem-solving, send your complete resume to Professional Placement, Dept. 353, P. O. Box 5907, Dallas 22, Texas. An equal opportunity employer.

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names in the news

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Robert E. Chasen: Elected executive vice president of ITT Kellogg Communications Systems, Chicago.

Arnold W. Runge: Appointed manager of new projects at Vitro Corp. of America's West Orange, N. J., laboratory.

Dr. R. L. Pritchard: Joined Motorola's Semiconductor Products Div., Phoenix, Ariz., in the newly created post of director of engineering.

David MacMorris: Appointed manager of applications engineering at Sundstrand Aviation-Denver.

Dr. Harold Goldberg: Elected vice president—engineering and research, for Raytheon Co., Lexington, Mass.

Joseph C. Ceva: Appointed director of marketing for Federal Electric Corp., Paramus, N. J. **Angelo J. Meluso** named deputy director—marketing.

Tom Brath, Jr.: Appointed director of industrial relations for Microlab, Livingston, N. J.

Alexander F. Giacco: Named director of the Explosives Div. of Hercules Powder Co.'s Explosives and Chemical Propulsion Dept., Wilmington, Del. **Richard G. Sailer** named manager of operations for the Chemical Propulsion Div.

Thomas L. Herb, Jr.: Named controller of General Kinetics Inc., Arlington, Va., and its subsidiary, Computer Test Corp., Cherry Hill, N. J.

John M. Magida: Appointed manager-instrumentation for KRS Electronics, Palo Alto, Calif.

Beverly H. Warren: Named vice president and general manager of Avco Corp.'s Lycoming Stratford Div., Stratford, Conn.

Joseph E. Trankla: Appointed vice president and assistant corporate treasurer of Anadit, Inc., South Gate, Calif.

Edward Pepper: Appointed director of the *Nike-Zeus* Target Program of the San Bernardino, Calif., operations of the Aerospace Corp. **Alex Petrovsky** named manager, integration engineering, of the *MMRBM* program, and **Thomas R. Hershey** appointed section head, computer systems and operations, Computation and Mathematics Center of the Technical Div.

Joseph G. Neuland: Appointed marketing manager of the Marquardt Corp.'s Pomona, Calif., division.

James J. Keenan: Appointed test supervisor for Electronic Memories, Inc., Los Angeles.

H. Brainard Fancher: Named general manager of General Electric Co.'s *Apollo* Support Dept., Syracuse, N. Y.

Dr. Diane Ramsey: Joined Astropower, Inc., Newport Beach, Calif., as a senior scientist in the Research Div.'s electronics laboratory.

Jeremiah J. Sullivan, Jr.: Appointed product specialist for the missile and rocket industry by Taylor Corp., Valley Forge, Pa.

Philip D. Wood: Appointed chief electromechanics engineer for Kinetics Corp., Solana Beach, Calif.

George E. Jacques: Appointed operations manager for the Thompson Ramo Wooldridge Microwave Div., Canoga Park, Calif.

Martin Rubin: Appointed director of engineering for Waugh Engineering Div. of the Foxboro Co., Van Nuys, Calif.

Col. Robert R. Malone (USA ret.): Appointed staff engineer at the Chicago center of Motorola's Military Electronics Div.

Raymond C. Harbert: Appointed director of customer service at General Dynamics/Astronautics, San Diego, Calif.

Ray G. MacInerny: Named San Francisco district manager for Packard Bell Computer Div. of Packard Bell Electronics, Los Angeles.

George Sarvadi: Appointed manager of engineering sales for the Process Equipment Div. of Falls Industries, Inc., Solon, Ohio.

Spencer B. Varian: Appointed West Coast regional manager for the Singer Metrics Div. of the Singer Manufacturing Co., Los Angeles.

—when and where—

MAY

American Institute of Aeronautics and Astronautics and Institute of Radio Engineers, National Aerospace Electronics Conference, Biltmore Hotel, Dayton, Ohio, May 13-15.

Instrument Society of America, National Power Instrumentation Symposium, Hotel Bellevue-Stratford, Philadelphia, May 13-15.

Industrial Research Institute, Semi-Annual Meeting, Fairmont Hotel, San Francisco, May 15-17.

Fourth Annual Symposium on High-Speed Testing, sponsored by Plas-Tech Corp., Hotel Somerset, Boston, May 15-16.

Institute of Radio Engineers Symposium on Artificial Control of Biology Systems, University of Buffalo, Buffalo, N. Y., May 17-18.

American Society for Quality Control, Annual Convention and Exhibit, Sherman House, Chicago, May 20-22.

National Telemetering Conference, sponsored by ISA, AIAA, AIEE and IRE, Hilton Hotel, Albuquerque, N. M., May 20-22.

Institute of Radio Engineers, National Symposium on Microwave Theory and Techniques, Miramar Hotel, Santa Monica, Calif., May 20-22.

Design Engineering Show, New York Coliseum, New York City, May 20-23.

Reliability and Maintainability Training Courses, sponsored by Arinc Research Corp., Hotel Willard, Washington, D. C., May 20-24.

Third European Spaceflight Symposium, sponsored by the British Interplanetary Society (BIS); Société Française d'Astronautique (SFA), and Deutsche Gesellschaft fur Raketentechnik und Raumfahrt e. V. (DGRR), Stuttgart, West Germany, May 20-24.

Aviation/Space Writers Assn., Silver Anniversary Meeting and News Conference, Hotel Adolphus, Dallas, May 21-24.

Lunar Surface Materials Conference, sponsored by Air Force Cambridge Research Laboratories and A. D. Little, Inc., Hotel Somerset, Boston, May 21-23. (Restricted)

Institute of Electrical and Electronics Engineers, Seventh National Conference on Product Engineering and Production, Continental Hotel, Cambridge, Mass., May 27-28.

JUNE

Third Annual Reliability Institute, University of Connecticut, Storrs, June 2-14.

SAMPE Symposium on Space Power Systems Materials, Bellevue-Stratford Hotel, Philadelphia, June 3-5.

COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland, June 3-11.

National Electronic Packaging and Production Conference, New York Coliseum, New York City, June 4-6.

Symposium on the Exploration of Mars, sponsored by the American Astronautical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections and NASA, Denver Hilton, Hotel, Denver, Colo., June 6-7.

25th French International Air Show, Le Bourget, Paris, France, June 7-16.

Reliability Training Conference, sponsored by American Society for Quality Control, The Bishop's Lodge, Santa Fe, N. M., June 10-14.

AIAA Heat Transfer and Fluid Mechanics Institute, California Institute of Technology, Pasadena, June 12-14.

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The Other Side of Space

SOME WEEKS AGO, just after learning he had been named the first recipient of the new National Medal of Science, Dr. Theodore von Karman took an hour out of his busy day to discuss his elder statesman's view of engineering philosophy with MISSILES AND ROCKETS editors William Beller and Frank McGuire.

The interview in Dr. von Karman's suite at the Mayflower Hotel was a casual one, roaming over many aspects of our entry into the Space Age. We carried the interview in the issue of last February 25.

Before he left for Germany, Dr. von Karman made a date with Beller and McGuire for one of his beloved Hungarian dinners—after his return. He won't be back for the dinner.

Dr. von Karman's death after a heart attack in Aachen last week left a void in the scientific community that never will be filled—although he wouldn't much like our use of that word "scientific." He liked to think of himself as an engineer. Not a scientist or an inventor but a creator of hardware.

"I say hardware because it is not a shameful thing to create hardware," he commented.

He recalled how first he got his engineering diploma in Budapest 60 years ago. Then, to get the degree and title of engineer, the young Von Karman had to design an entire hydraulic system—not just a machine but a system.

"The old way was good because it showed that the engineer had to create something," he emphasized.

This legacy of devotion to engineering may be one of the finest gifts Dr. von Karman has left behind. Coming from one so highly regarded in the scientific world, it stresses the need for engineering and science to complement each other in our exploration of the universe.

"We should not forget that without the engineer there will be no progress," he warned.

It is a warning we hope will be kept in mind. Today, with scientists taking public stands on public issues far beyond their own realm, it is perhaps well to remember the gap between the scientist and the hard-headed practical engineer.

This past week, 25 of America's 55 living Nobel Prize winners took it upon themselves to criticize the present direction of Project *Apollo*. This dissent from the scientific community should not be taken seriously because it is not within the competence of the Nobel group, however distinguished, to determine how much the U.S. should spend on its lunar program.

Certainly, as American citizens, they have a perfect right to criticize as they please, privately or publicly. We just hope their fellow citizens don't take them too seriously in the belief that the scientists are indeed qualified to judge this subject.

Linus Pauling, for example, in expressing strong opposition to the U.S. Moon program, merely reiterated the same muddle-headed thinking that is confusing many of his fellow scientists. He said: "The contribution will be very small compared to putting that money into several other fields such as medical research or other basic scientific research . . . or in using the funds in underdeveloped countries."

How often is it necessary to point out that cancellation of the lunar program tomorrow wouldn't mean an additional dime for these other pet projects that are continually being put forward? Worthy they may be, but there was ample opportunity before initiation of the lunar program and there is ample opportunity now to fund such other programs. They stand or fall on their own worth—not in relation to what is being spent for space exploration. This country is wealthy enough to fund amply, on its own merits, any program it regards as essential.

The *Apollo* project is so regarded and so funded.

The wire services didn't provide us with the names of the three Nobel winners who declined comment on the U.S. Moon program, saying they did not have enough data on it or that the political and scientific aspects of the program cannot be separated. We would, however, like to laud those three anonymous gentlemen for their uncommon good sense. There obviously were 25 of their colleagues who should have taken the same stand.

DR. VON KARMAN understood well the need for space exploration. Practical in his approach to the Earth on which he lived, he still could look outward to envision the day of flight to the planets and even to other galaxies.

We doubt if even those who knew him well were aware of the full range of his career. After early work as an engineer and professor in Germany and Hungary, he served as an officer in the Austro-Hungarian Air Corps in the first World War. After that war, he was a consultant to the Junkers Airplane Works. He designed a wind tunnel in Kobe, Japan. He was an advisor in aeronautics to the National Tsing Hua University in Peiping, China. His valuable work as consultant to the Army Air Corps and U.S. Air Force began in 1939. His roles at Cal Tech and NATO were well known, of course, together with his founding of the company which was to become Aerojet-General Corp.

But Dr. von Karman's interest and abilities were not limited to aeronautics and astronautics. He applied his knowledge in development of pumping equipment for the Los Angeles water system and in investigation of the Tacoma Narrows Bridge collapse.

He was consultant to a number of aircraft firms and received honorary degrees from universities in Germany, Belgium, Israel, Switzerland, France, Turkey, The Netherlands, and the United States. His list of awards from many nations is staggering. He was truly an international statesman and the senior statesman of our industry.

In his last interview with us, considering the subject of intergalactic probes, Dr. von Karman mused: "I will consider this one from the other side of space." And so he will.

We wish him affectionate farewell and Godspeed on that long journey to the other side of space.

William J. Coughlin

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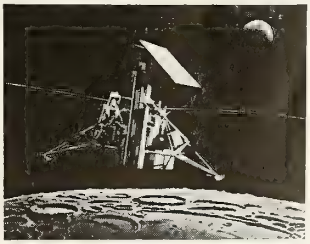

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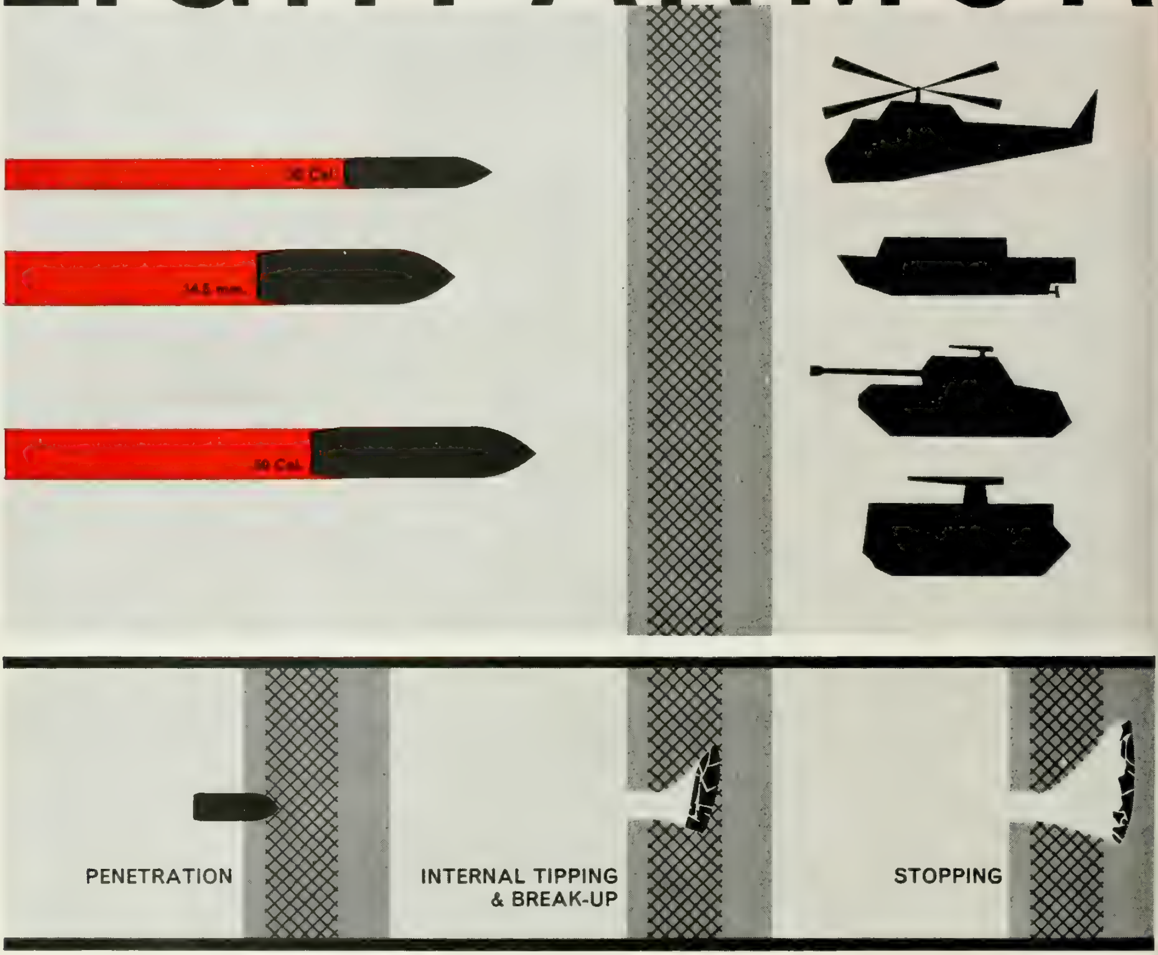
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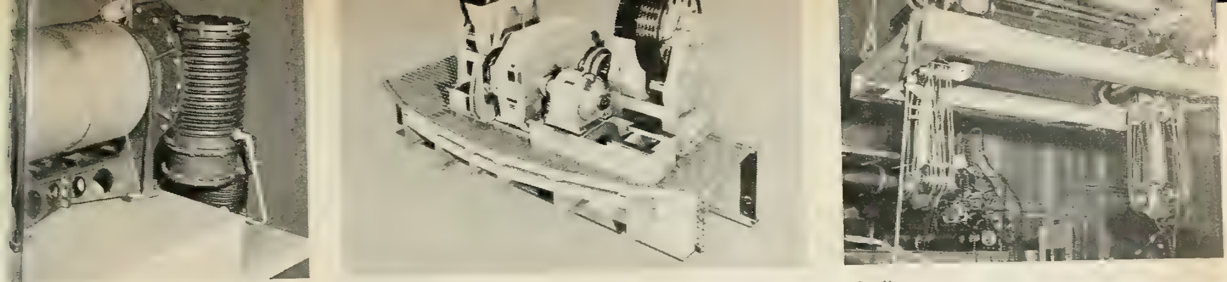

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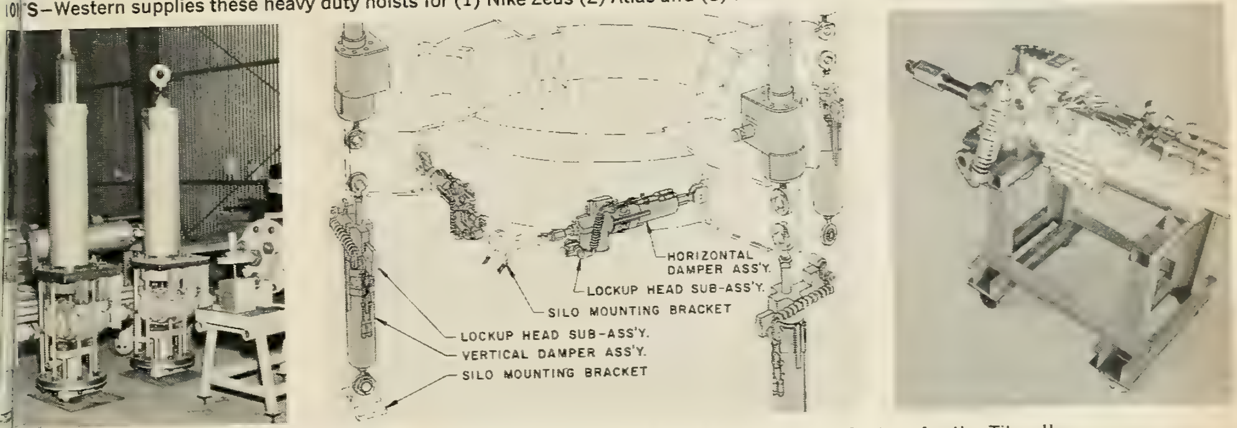
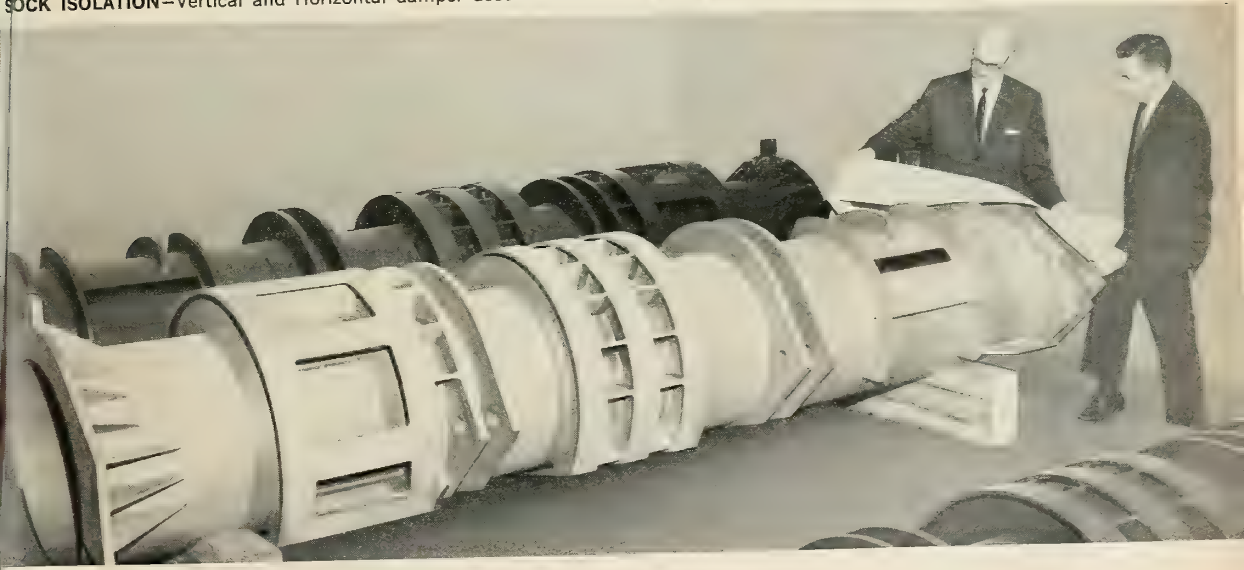


OCK ISOLATION—Vertical and Horizontal damper assemblies of Western's Shock Isolation System for the Titan II.



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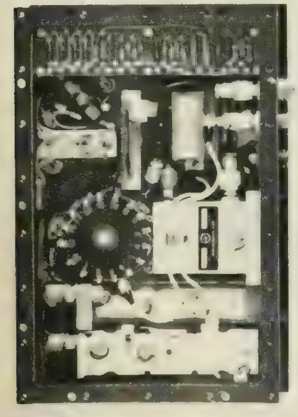

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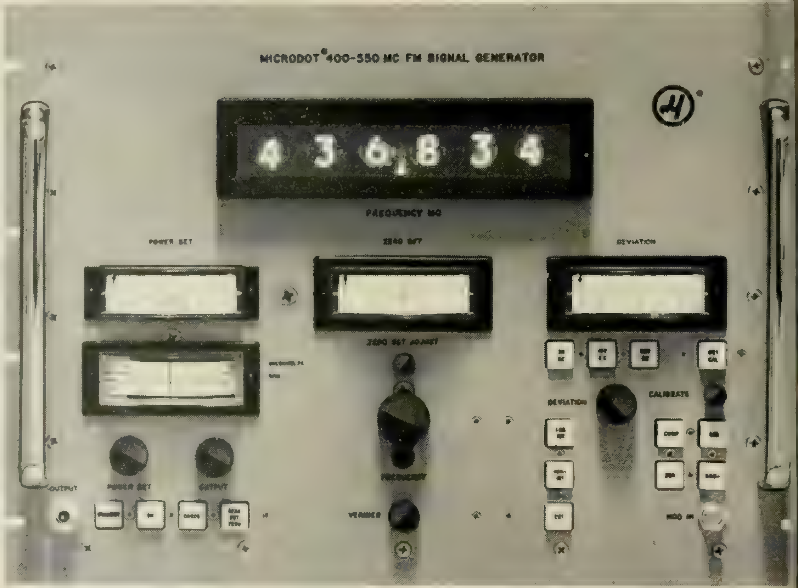

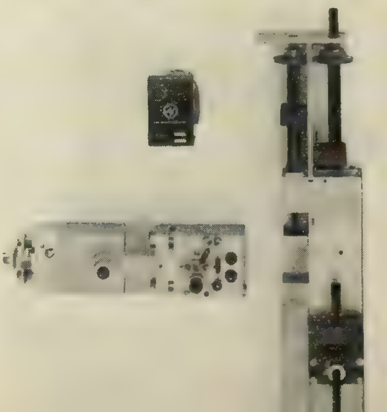

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missiles and rockets

Volume 12, Number 20

May 20, 1963

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THE COVER

Air Force Maj. L. Gordon Cooper last week became the sixth U.S. citizen to visit space, his MA-9 flight giving the manned spaceflight program a big thrust forward. A report on the Cooper trip starts on p. 10.

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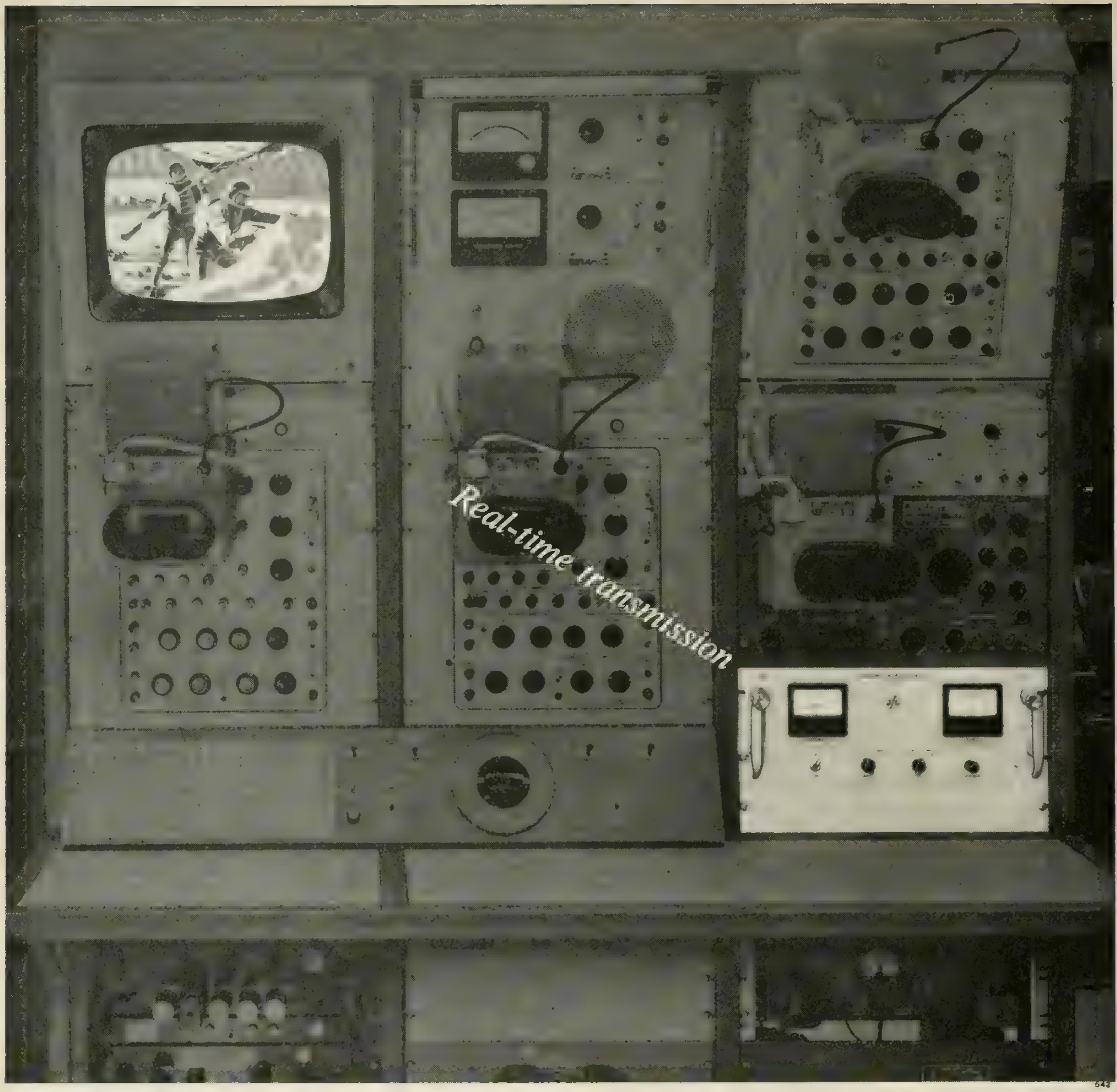

If a TV signal were beamed earthward from the surface of the moon tomorrow, a wideband phase-lock demodulator built by STL could pick it up and faithfully reproduce it. The new demodulator is already aboard Project Relay. Two important advances in FM design distinguish the STL demodulator. First, it allows reduction of spacecraft transmitter power by a factor of four. Second, its loop 3 db bandwidth of 7.5 megacycles is wide enough for real-time transmission of full bandwidth television or multichannel telephony. Scientists and engineers interested in advancing the art of space communications will find STL an active place. STL builds spacecraft for NASA and Air Force-ARPA, and continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings for Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Redondo Beach, California, Department B-5-4, or Post Office Box 4277, Patrick Air Force Base, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Goddard Gets Mariner Assignment

NASA officials have decided to give Goddard Space Flight Center the management responsibility for 1966-67 *Mariner* missions to send landing capsules to Mars and Venus. This probably will lead to assignment of *Voyager* program management to JPL—with a prime contractor selected to develop the 6,000-lb. spacecraft.

AADS-70 Study Contracts Are Awarded

Feasibility study contracts for *AADS-70,* new field army air defense system, have been awarded to Raytheon Co., Hughes Aircraft and Radio Corp. of America. Raytheon will work with IBM and Northrop; Hughes with FMC Corp. and Douglas Aircraft (Charlotte, N.C.); and RCA with Beech Aircraft. Primary emphasis on *AADS-70* will be on anti-tactical ballistic missile capability for the 1970's.

Navy Looks Beyond 41 Polaris Subs

Navy is conducting research into possible *Polaris* system improvements which might call for enlarging the presently planned fleet of 41 submarines.

First Titan II for Gemini Due at Cape Soon

First *Titan II* committed to the *Gemini* program is expected to arrive at Cape Canaveral in about two months. It will face a long series of ground tests but should be ready for the first unmanned ballistic launch early in 1964.

Shillelagh Scores High in Arctic Tests

Four consecutive successful target impacts in one week by the *Shillelagh* missile concluded winter-long testing of the weapon under severe Arctic conditions. The Alaskan tests were the latest in a series to assess the anti-tank weapon under a variety of battlefield conditions.

Little AF Interest Yet in Atlas Proposal

General Dynamics/Astronautics still has not sold its five-engine *Atlas* booster proposal to the Air Force. The advanced *Atlas* is designed primarily for space mission use with a payload capability of over 10,000 lbs. Engines would develop about 200,000 lbs. thrust each.

Kennedy Gets $15.3 Billion Defense Bill

Congress has sent a $15.3-billion defense procurement authorization for military weapons and R&D to the White House. The action came swiftly after agreement by House and Senate conferees on a compromise bill which was $371.9 million higher than the amount approved by the Senate but $533 million less than okayed by the House. A $30-million Senate cut in funds for the Army's *Pershing* missile was halved. A $12.2-million Senate reduction in Navy funds for the *Subroc* missile was restored. The entire $75.8-million Senate cut in the Air Force missile procurement account also was restored.

INDUSTRY

Powers To Bow Out of Spaceflight Program

Cape Canaveral sources indicate that *MA-9* was the last assignment for Lt. Col. John (Shorty) Powers as the Voice of *Mercury* Control. He is expected to return to the Air Force for future assignment. This also means the position of director of public information at the Manned Spacecraft Center will be open.

Gemini System Tracks MA-9 Flight

The Teltrac tracking system designed for Project *Gemini* by Canoga Electronics Corp. successfully tracked and received data from the *MA-9* spacecraft flight. The test was conducted at the plant of the Southern California manufacturer. Tracking, voice reception and telemetry reception were sporadic because the *MA-9* beacon was not always turned on as the spacecraft approached the California coast. Teltrac, a passive system, cannot acquire the target with the beacon off. Teltrac will be used in the *Gemini* project to make initial acquisition for tracking radars and then will function as a telemetry receiver.

Sproul To Replace Ruina as Chief of ARPA

The director of Cornell University's Materials Science Center, Dr. Robert L. Sproul, will succeed Dr. J. P. Ruina as director of Advanced Research Projects Agency. Ruina has announced he will leave ARPA this summer to return to university life.

AF Announces Medium-Altitude ComSat Awards

General Electric and the team of Philco Corp. and Space Technology Laboratories have been selected by the Air Force for program definition studies of a medium-altitude communications satellite system. Each of the contract recipients will propose a technical approach, prepare detailed cost estimates and define management and work schedules. Funds for the project include $90 million in the FY '63 budget and $60 million in FY '64.

Advanced Glotrac System Used for MA-9

The advanced Glotrac system designed and built by General Dynamics/Astronautics got its first workout during the *MA-9* launch when it tracked the *Atlas* booster from vans located at Cape Canaveral and Grand Bahama Island. The passive tracking was carried out to verify accuracy of the Glotrac system which soon will be operational. Other stations will be located at San Salvador. Antigua and Cherry Point, N.C.

Westinghouse Develops New Solar Cells

Development of solar cells 15 times larger than those now in use on current space hardware has been disclosed by the Semiconductor Division of Westinghouse Electric. The devices are made from a strip-form single-crystal silicon made from silicon dendrites.

INTERNATIONAL

U.S. Firms May Bid on Norway Rocket Bases

Under NATO's competitive bidding procedures, U.S. firms are being permitted to bid on a $225,000 rocket storage project in Norway. Rocket storage facilities will be constructed at five airfields at $45,000 per site.

Bell Holds Navy Contract for CT-41 Tests

Six Nord Mach 2.5 *CT-41* target missiles will be tested at Point Mugu, Calif., under the $1.7-million Navy contract to Bell Aerosystems for evaluation of the missile. Bell is U.S. licensee of the French manufacturer.

MA-9 Boosts Hopes for Tenth Mission

NASA is now expected to attempt a 72-hour *MA-10 Mercury* mission as a follow-on to last week's successful 22-orbit, record-breaking U.S. manned space flight by Astronaut L. Gordon Cooper.

The *MA-10* mission would cost $8 to $9 million. Officials of NASA's Office of Manned Space Flight and Manned Spacecraft Center would like to do it.

On the other hand, one key NASA official opposes the additional flight because he doesn't believe its potential benefits justify the cost.

The chances for an *MA-10* mission improved immeasurably, however, when trouble developed in the *MA-9's* automatic control system during Cooper's nineteenth orbit. The trouble was later tracked to loss of both of the inverters which supply electrical power to ASCS. This forced Cooper to fire the retro-rockets manually and control the re-entry descent using the fly-by-wire system.

This he accomplished successfully, with retro-fire at 7:04 p.m. EDT May 16.

• **Mercury-Gemini gap**—Also aiding supporters of an additional *Mercury* mission is the 18-month gap before Project *Gemini* begins.

A final decision will be made in two weeks, following evaluation of data from the *MA-9* flight, which was described by space agency officials as the "most successful yet."

The McDonnell-built *MA-9* capsule blasted off from Cape Canaveral at 9:04 a.m. EDT on May 15. It whirled around the Earth 22 times in an orbit ranging from a perigee of 100.2 miles to an apogee of 165.8 miles. Its orbital inclination was 32.5 degrees and its period was 88.5 minutes.

Thirty-four hours, 20 minutes and 30 seconds later, Cooper impacted in the Pacific Ocean about 80 miles southeast of Midway Island at 7:25 p.m. EDT. He was successfully recovered at 8:01 p.m. EDT by a crane aboard the aircraft carrier USS Kearsarge. Four minutes later the egress hatch was blown off his *Faith 7* capsule and the astronaut stepped on deck.

Earlier plans had provided for helicopter recovery of the capsule, but when it came down within two miles of the Kearsarge the carrier steamed over to pick it up.

During the flight, Cooper travelled an estimated 593,885 statute miles around the Earth at 17,546 mph in the longest manned space flight ever made by an American.

Highlights of the MA-9 flight included:

Orbital insertion of the *Mercury* capsule was almost perfect as it came within one foot per second of the desired speed of 25,716 fps.

Further evidence was provided that man can live in space for an extended time with no ill effects. Cooper reported absolutely no difficulty from the long period of weightlessness, and the *Mercury* medical team said that his pulse, respiration rate and body temperature were all "nominal."

The only potentially serious problem was the failure of the capsule's automatic control system. The NASA flight operations team and the *Mercury* capsule functioned nearly perfectly.

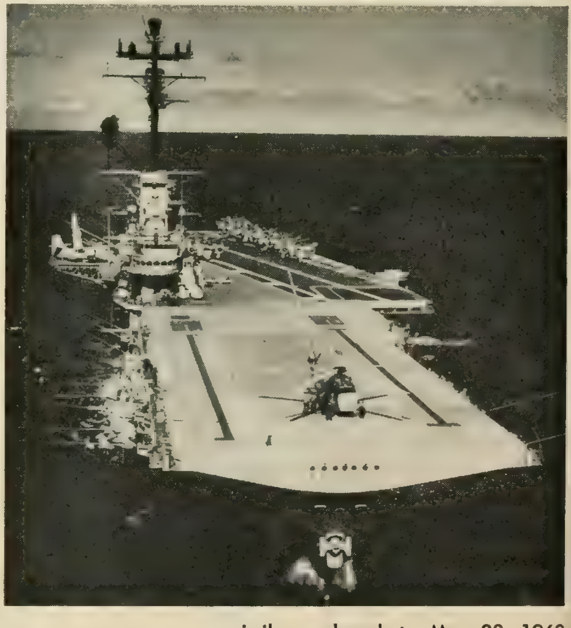
• **MA-10 consideration**—NASA officials originally said that if *MA-9* were successful it would be the last shot in the *Mercury program*. They now admit the three-day *MA-10* flight is under consideration (M/R, April 1, p. 14).

One of the main reasons for attempting the mission is that it would provide data on the effects of weightlessness on man during a flight twice the duration of *MA-9*. In addition, new flight experiments could be conducted.

(Continued on Page 12)

LEFT: *MA-9 launch from Cape Canaveral May 15 put Cooper in near-perfect orbit to begin 34-hour trip. Shot was .0002 of a degree from target window, velocity within one fps of perfect.*

RIGHT: *Aircraft carrier USS Kearsarge, stationed 80 miles to southeast of Midway Island, picked up Cooper and Faith 7 capsule after 22-orbit trip covering 593,885 miles.*



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Informed sources report that D. Brainerd Holmes, director of NASA's Manned Space Flight program, and Walter Williams, mission director for *Mercury*, both favor an *MA-10* mission.

Dr. Robert C. Seamans, Jr., NASA associate administrator and the man who holds the purse strings, is opposed to another *Mercury* shot.

Whether or not he can be convinced the flight is necessary will probably not be determined for several weeks, and will presumably depend a great deal on the amount of pressure for the flight generated within the space agency, other areas of the Kennedy administration, and Congress.

One of the major questions to be answered is whether NASA should spend further funds on *Mercury* when its upcoming *Gemini* program has already been delayed for lack of funds. NASA has, however, spent considerable funds on modifications to the capsule and purchase of an *Atlas* booster for *MA-10*.

The other major factor to be studied by everyone evaluating the need for another flight is the 18-mo. gap that will separate *MA-9* from the first manned *Gemini* flight.

Opponents point out that even if an *MA-10* flight is made late this year, the gap before *Gemini* flights will still be 10 or 11 months.

A NASA official reported that the space agency still has three man-rated *Atlas* boosters and four *Mercury* capsules, including one which has already undergone extensive modifications for a longer mission.

Representatives of the Project *Mercury* contractor teams said they were anticipating another mission. They said that while the mission is planned, no official go-ahead is expected for some time.

Apart from wanting more information on the effects of extended periods of weightlessness, Manned Spacecraft Center scientists have proposed a long list of new experiments which they would like to conduct during the mission.

Manned Military Satellites May Use MA-9-type TV

SUCCESSFUL EXERCISE of a TV camera-transmission system aboard the *MA-9* spacecraft may point the way to application of that system to reconnaissance work in manned military satellites.

NASA spokesmen said before the flight that Astronaut Gordon Cooper "probably will try to photograph China" during one of his passes over that nation.

But the photography of the Communist nation was a minor objective of the tests scheduled for the system during the three hours it would operate aloft.

Cooper was slated to photograph himself and the spacecraft instrument panels with a moderately wide-angle lens and to make test shots of the Earth and sky through the spacecraft window while using a longer-focal-length lens.

The self-portraits were required by NASA medical men, who said the astronaut's physical condition could be more accurately assessed by watching his face while he talked. The view of the instrument panel was designed to back up telemetry.

Photography of China was optional during the TV test program but the Pacific command ship, Coastal Sentry Quebec, was located south of Japan in a position to acquire and tape TV signals during *MA-9's* flight over the Chinese mainland. These signals could be received only at line-of-sight stations at Cape Canaveral, Canary Islands and the Pacific Command Ship.

Cooper was scheduled to cross portions of China on orbits 7, 8, 9, 10, 11, 22 and 23. He was scheduled to sleep during orbits 9 through 15, leaving orbits 7, 8, 22 and 23 as possible times to photograph Chinese mainland areas.

• **Like Echo**—Cooper's TV equipment consisted of a 9.3-lb. camera and transmitter system produced by Lear Siegler, Inc., Santa Monica, Calif. It used 60 watts of power for complete operation.

The slow-scan camera produced one picture every two seconds and utilized a one-inch lens for wide-angle photography and a six-inch lens for photographing distant objects. The longer lens produced a 500-line square image that covered an area nine miles on the side from a 100-mile altitude.

Lear Siegler representatives said the equipment was almost identical to that which photographed the *Echo* balloon, with the exception of scan speed. The *Echo* TV equipment was set for a fast scan of 30 pictures a second.

They added that conversion of the equipment for fast-scan would take much more power for direct transmission, and that a taping device would add a great amount of weight to any spacecraft.

One would be similar to the electron measurement experiment included in *MA-9*. The *MA-10* experiment would measure instead the protons at the *Mercury* spacecraft's orbital altitudes. It also would give information on the decay of the artifically created radiation belt.

Another test would study the electrostatic charges outside the space craft. This study is important for later rendezvous flights in Project *Gemini*. If the charge is sufficiently high, it could affect attempts to link up two vehicles in orbit.

One experiment which NASA officials are anxious to attempt would involve a possible solution to the loss of communications with spacecraft during re-entry. Small amounts of water would be sprayed into the ionized particle layer around the spacecraft to neutralize them and halt the radio interference.

- **MA-9's flight**—The *Atlas* launch vehicle chalked up an almost perfect performance. The spacecraft velocity of 25,716 ft. per second was only 1 ft. per second higher than the planned velocity of 25,715 ft. per second. Perigee was 86.8 miles, only 400 ft. below the planned low altitude of 86.97 miles.

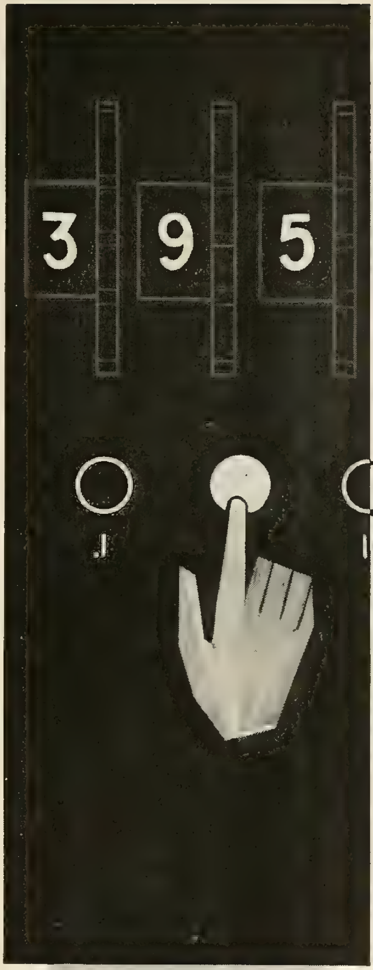
B. G. McNabb of General Dynamics declared that the *Atlas* "couldn't have performed better. It is the result of additional experience of NASA and contractor personnel and the refinement of equations."

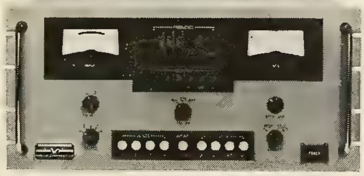
MA-9 blasted off at 9:04 a.m. EST exactly on schedule, with none of the technical delays which plagued the earlier attempt on May 14. During that launch attempt Cooper was forced to remain in the spacecraft for more than six hours. The series of mishaps included accidental ejection of the umbilical cord, failure of the diesel engine to move the gantry back, and technical problems with the data-handling equipment at the Bermuda tracking station, which finally postponed the flight.

Early in the first orbit, there were indications that the temperature problem which has occurred in earlier *Mercury* flights was cropping up again. Ground instruments recorded the spacecraft temperature as 118°F.

This was blamed later on faulty ground equipment during the fourth orbit. *Mercury* officials reported that the spacecraft temperature was 93°F, adding that it had stabilized at that point.

The suit temperature problem—present in the *MA-7* and *MA-8* flights—was apparently solved, as just about perfect temperatures of 58°F were reported.





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Shortly before the end of the first orbit, the go-ahead was given for at least a seven-orbit mission. In the fourth orbit, after refinement of data, flight officials said that the vehicle's orbital characteristics gave it a capability of 92 orbits.

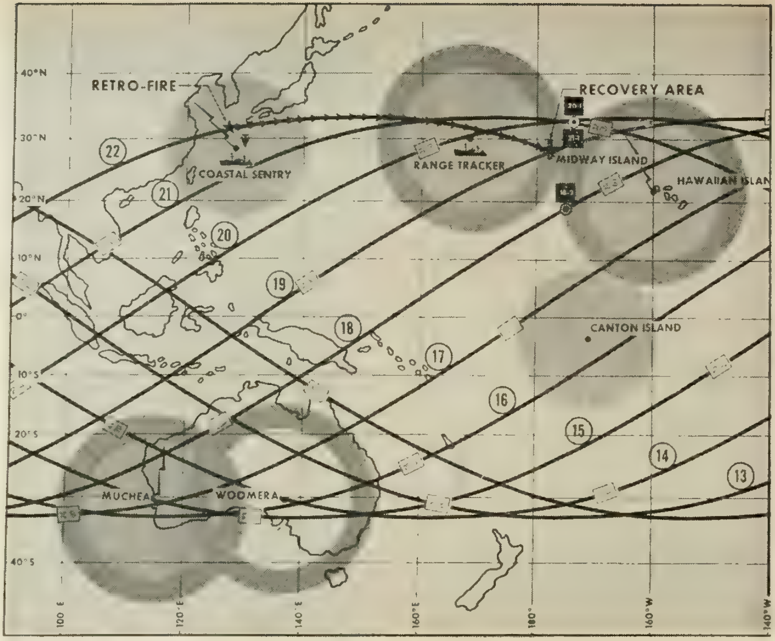
In addition to again proving the capability of the *Atlas* booster and *Mercury* capsule, the mission provided further evidence that extended orbital flight has no ill effects on man.

The *Mercury* medical team reported no evidence that the long period of weightlessness had any bad effect on Cooper. They also said that his pulse rate averaged between 80 and 90 per minute, with occasional rises to 100 during periods of activity. All this, they said, was within prescribed limits.

Most of Cooper's time from the second to the eighth orbit, after status reports and instrument checks, was devoted to the various experiments included in the flight plan.

- **Elusive beacon**—One of the most important was a flashing beacon experiment deployed during the second orbit.

The test was designed to provide information as to whether visual sighting of a beacon at distances of 15 miles could be used during the rendezvous operations in Projects *Gemini* and *Apollo.*



OFFICIAL CHART shows Midway Island recovery area.

The beacon had two flashing xenon lights designed to equal a star of the magnitude of Polaris (the North Star) at a distance of six to eight miles.

The test seems to have proved that such a beacon could not be used for daylight operations. Shortly after the beacon's deployment, Cooper reported that he could not pick it up. Later, as the fourth orbit neared its end, he said that he saw the beacon during the night portion of the orbit. At his first sighting, the beacon appeared to be 12 to 13 miles away, with the brightness of a second-magnitude star. He reported a second sighting when it appeared to be 8 to 10 miles away, and a third sighting when he said it was very dim, with the brightness of a fourth- or fifth-magnitude star.

- **"Very good" pictures**—The TV camera also produced good results. This experiment employed a 10-lb. camera to take pictures of the astronaut inside the spacecraft, as well as of external phenomena.

Officials reported that pictures and signal from the spacecraft were of good quality. Light inside the capsule was only fair, but pictures taken outside the spacecraft were termed "very good." Shots taken included Mexico's Yucatan Peninsula near the end of the fourth orbit.

- **Counting particles**—The radiation measurement experiment was turned on for 10-minute periods many times during the flight. Because of the long time required to decipher data collected, the results of this experiment will not be known for some time.

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It was designed to measure electron particles trapped in the lower regions of the Earth's magnetic field closest to the terrestrial surface above eastern South America and the South Atlantic.

During the sixth orbit, two experiments were attempted with mixed success.

- **Bright light**—One was a study of the use of a ground to high-altitude light for use as navigation fixes in mid-course and near-Earth corrections in Project *Apollo*.

A 3-million-candlepower light was illuminated for three minutes as *Faith 7* passed over South Africa. Cooper reported that he saw the light clearly—indicating that such equipment may prove useful in future manned spaceflight missions.

The unsuccessful experiment called for the deployment of a 30-in. balloon which was to be used for tracking as well as for visibility tests by the *MA-9* pilot.

Previously, the same test failed in the *MA-7* flight of Scott Carpenter when the balloon did not inflate. In *MA-9*, Cooper reported that he pressed the switch for the pyrotechnic deployment, but the experiment failed for some unknown reason.

- **Grain catcher**—A photographic emulsion pack carried inside the spacecraft may have ramifications for future spacecraft design.

The pack contained a series of eight glass plates coated with an emulsion sensitive to protons and galactic cosmic rays.

After the flight, a microscopic inspection of the developed grain intensity in the emulsion may supply information as to their energy and the direction from which they struck the pack.

The data are expected to help support or reject a theory that on future spacecraft, weight may be reduced by using shielding on only one side.

From the ninth to fifteenth orbits, Cooper spent much of his time resting and using his TV cameras.

- **Also aboard**—Other major experiments included studies of horizon definition and cabin environmental temperature, an HF antenna test, a window attenuation evaluation, and infrared photography.

The horizon definition experiment was conducted during the sixteenth

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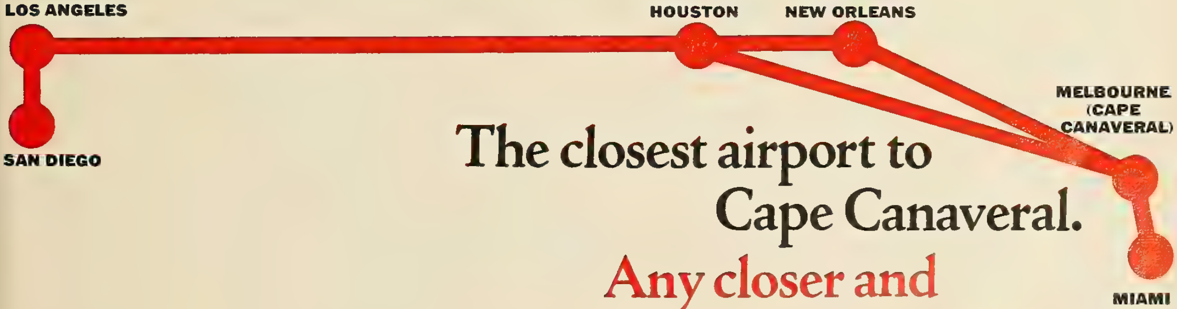

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MIAMI		9:37PM

WESTBOUND

	LEAVE	ARRIVE
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MELBOURNE	2:45PM	2:12PM
NEW ORLEANS	3:40PM	3:14PM
HOUSTON	5:00PM	4:32PM
LOS ANGELES	7:55PM	7:00PM
SAN DIEGO†		8:41PM

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orbit. Test results are expected to aid Massachusetts Institute of Technology's Instrumentation Laboratory in the development of the *Apollo* guidance and navigation system.

A 70-mm camera using red and blue filters was utilized along with black and white film to take pictures of the horizon.

Eight photos were taken, two in each quadrant, as Cooper performed a pitch-down yawing maneuver.

• **Marines out**—One major change in the *MA-9* operation was the shift of recovery responsibility from the Marines to the Navy.

The change became apparent when the USS Kearsarge steamed from Pearl Harbor with seven jet-powered HSS-2 helicopters on the deck. Missing were the familiar Marine HUS helicopters.

NASA failed to note the change in mission assignment in a detailed 68-page advance news release handed the press a week before the flight.

No official reason was given for delaying announcement of the change, but many felt it was to spare the pride of the Marine Corps. ■

Other Shots of the Week

It was a busy week at the launch pads. In addition to *Mercury*, the shots included:

• Two *Titan II's* were launched. The first, launched from Cape Canaveral May 9, missed its target due to premature cutoff of its second-stage engine. A May 13 *Titan II* shot from Vandenberg AFB, Calif., was a success.

• The *Minuteman* continued to progress with its fifth consecutive successful launch May 9 from Vandenberg.

• A *Polaris A3* was successfully fired from a pad at Cape Canaveral May 10.

• An *X-15* flight was cancelled a few minutes before release from the mother ship on May 10. A hydraulic system malfunction was blamed for the abort.

• NASA's inflatable *Paraglider* (M/R, May 13, p. 16-17), after what seemed a successful launch from an *Aerobee* sounding rocket May 13 at White Sands Missile Range, N.M., apparently failed to inflate and fell to Earth. Pieces of the glider, which was designed to gather meteoroid data, were found in the desert three hours after the firing.

• West Ford, the Air Force's controversial experiment in world-wide communications, released in space some 400 million tiny copper needles.

The needles, ejected from an Air Force satellite in orbit, are to provide a radio wave-reflecting band around the Earth.

NASA Seen Winning in AMR Dispute

A SHARP NASA-DOD disagreement over management of the Atlantic Missile Range is expected to be resolved in the space agency's favor.

Prime issue is management of the tracking network for Project *Apollo*, but other management and contracting issues are involved.

The DOD position is that the world-wide tracking network, which is used for missile as well as NASA launches, should be directed by a single agency—specifically, the Air Force, which is currently responsible for AMR's tracking stations.

NASA holds that since it is charged with the high-priority *Apollo* project, it must have control of all facets of the program to insure success.

Discussions are now being held at Cape Canaveral between officials of both agencies in an effort to solve the problem. Other top-level negotiations are being conducted in Washington, D.C., between Gen. Paul Cooper and Edward Buckley, Director of NASA's Office of Tracking and Data Acquisition.

A high Administration official told MISSILES AND ROCKETS that at this point, it looks as though NASA will win the argument.

• **Switching signals**—If this occurs, it will be a direct contravention of the January, 1963, NASA-DOD agreement on Atlantic Missile Range operations.

In addition to giving the Air Force the role of host agency of the 15,000-acre Cape Canaveral area, that agreement gives it certain other range responsibilities including security, scheduling, frequency control and analysis, flight safety, sea surveillance, airlift, down-range stations (tracking) and operations at Port Canaveral.

The issue was aired recently in testimony before Congress, which may play a large role in the final solution.

NASA has requested $90 million in its Fiscal '64 budget for construction of three tracking ships for the *Apollo* network. Air Force officials testifying before the House Space Committee declared that the Air Force wanted to build the ships for the space agency. They claimed that they had experience in the area, and could do the job cheaper.

They admitted before the committee, however, that two ARIS tracking ships which they are currently building have cost a total of $118 million, much higher than NASA's estimated cost.

In reply, space agency officials contend that *Apollo* has unique tracking requirements which have to be filled by new ships.

If Congress approves the funds for the NASA ships, the DOD position on management would become untenable.

• **Departures**—Even NASA's approach to building the ships differs from Air Force AMR operations.

The space agency favors using the Navy's Military Sea Transportation Service (MSTS) to handle the construction as well as procurement of standard ship equipment.

NASA would draw up ship specifications, as well as contract with industry for unique equipment and tracking instrumentation.

The Air Force currently handles its tracking ship development through Pan American World Airways, its prime contractor for range support.

NASA also is taking a new tack in administration and management of the new Merritt Island Launch Area (MILA), much to the chagrin of the Air Force, which wanted the agency to use the support services provided at Cape Canaveral by its own personnel and contractors.

The space agency instead has decided to select its own contractor team. An announcement of the request for proposals could come as early as two weeks.

At present, the agency does not intend to select one prime contractor who will subcontract other jobs to industry.

Instead, it will select one firm for overall coordination of operations. Its security arrangements may go to the same firm, but it is also possible a separate firm will be selected.

Several other contracts are expected to be awarded, including maintenance and repair of equipment, ground maintenance and offshore operations.

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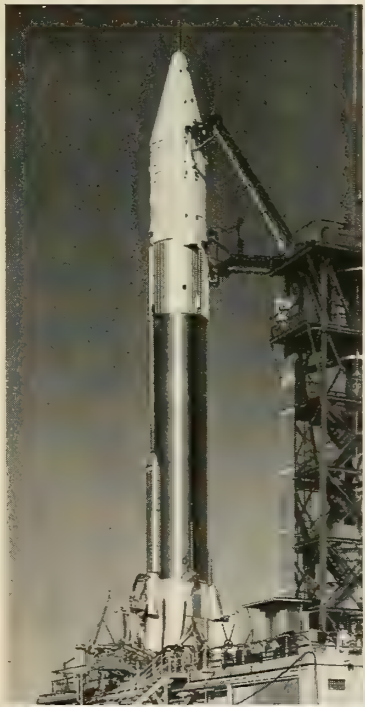

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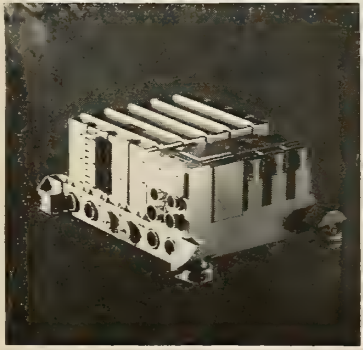

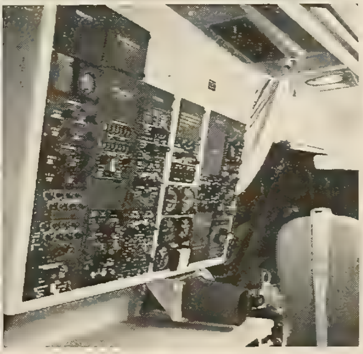

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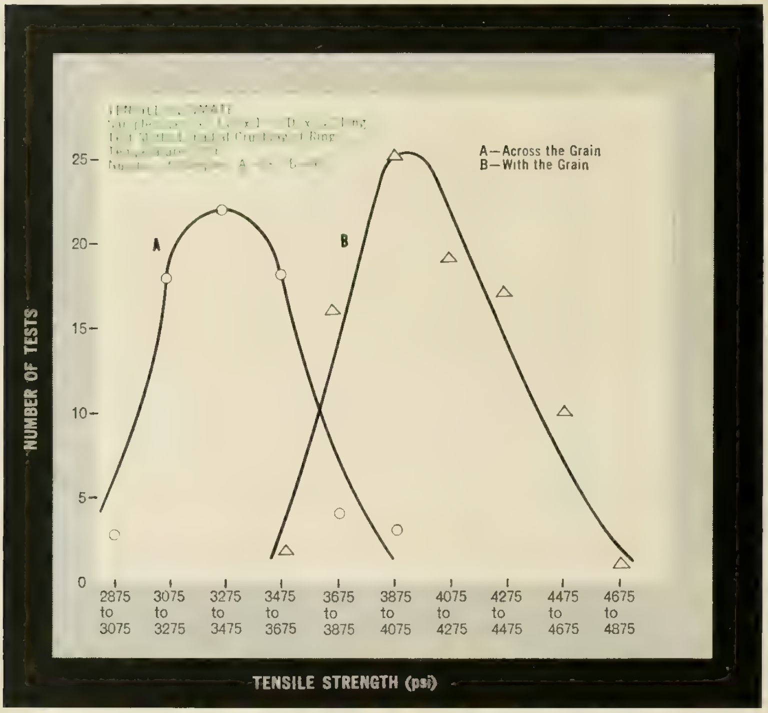

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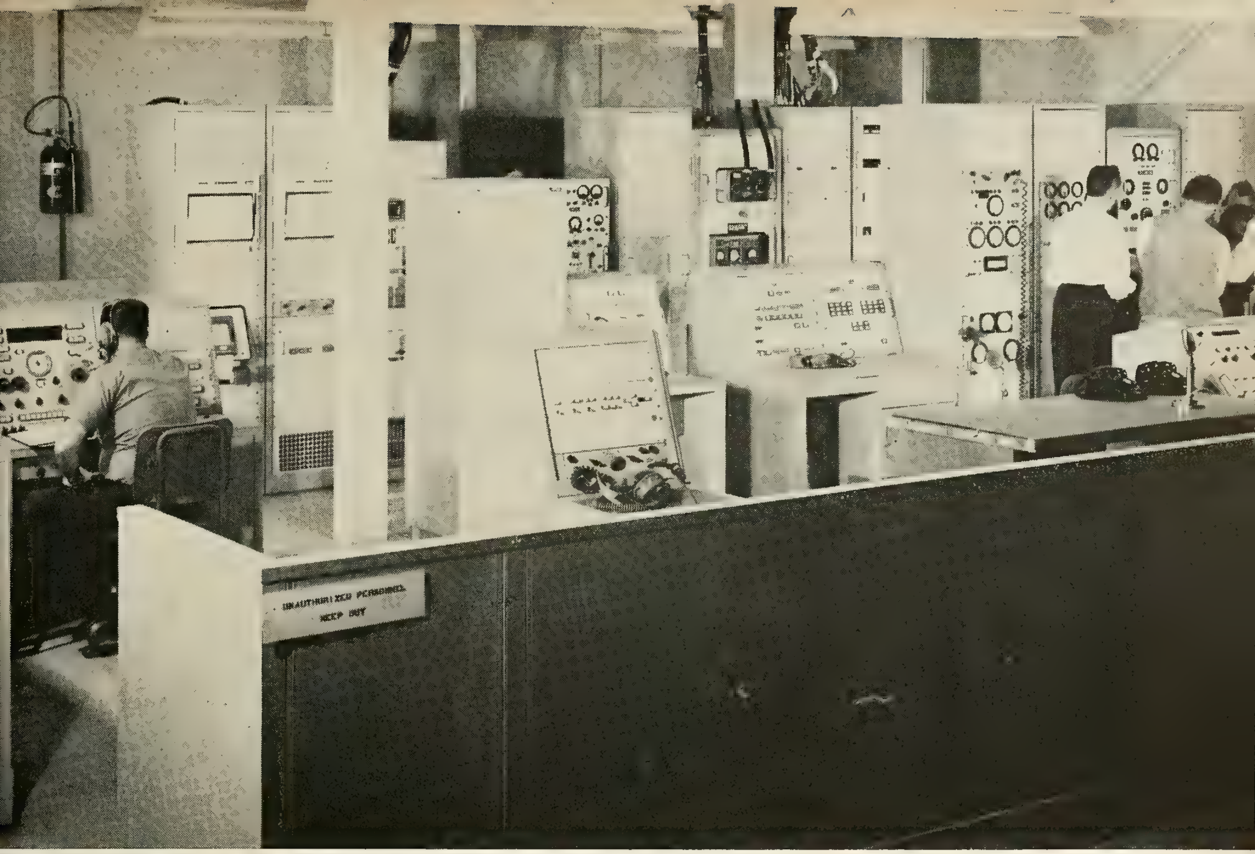


CHECKOUT CENTER for Titan II/Gemini vertical test stand at Martin-Baltimore.

Missiles and Rockets Volume XII, Number 20 May 20, 1963

SPECIAL REPORT: TEST & CHECKOUT

ON THE FOLLOWING PAGES, M/R Editors present a comprehensive report on the market and the state of the art of Test and Checkout in the U.S. missile/space effort. Compiled under direction of Senior Electronics Editor Charles D. LaFond, the Special Report covers:

- The market, with a forecast through 1970 and a discussion of factors influencing it . . . . p. 20
- Development trends, and major problems still remaining to be solved . . . . p. 25
- Advanced checkout concepts now in use or soon to be employed by the military . . . . p. 34
- Advanced concepts at NASA . . . . p. 43
- Current and future requirements for space simulation systems . . . . p. 54
- A state-of-the-art discussion of environmental test equipments and techniques . . . . p. 67

Sales To Top $8 Billion by '70

Combined DOD-NASA market exceeds $1 billion a year and is growing steadily; 'universal' testing downgraded

OVER $8 BILLION in government expenditures for missile/space test and checkout equipment is forecast for the next seven years. With the current annual market topping $1 billion, growth is expected to be moderate but steady.

Funding by the Department of Defense in Fiscal 1963 will total $745 million for missile and space system testing. The National Aeronautics and Space Administration's expenditures are now only about $185 million, but its rapidly expanding test and checkout needs reflect that agency's steadily rising total annual appropriation.

These conclusions concerning present and future markets for environmental test and systems checkout were drawn from responses to more than 100 questionnaires distributed by MISSILES AND ROCKETS throughout the industry. In addition, M/R editors interviewed scores of industry, government, and military experts in the field. The six-part special report starting with this article offers a view from the inside of a rapidly changing technology, summarizes current R&D trends, and describes new test and checkout systems and techniques that will be employed by the missile/space industry.

• **"Universal" huckstering out**—Biggest single change in the checkout market is the de-emphasis of so-called universal automatic testing.

Four years ago there was a major effort on the part of many manufacturers to sell the idea of these handy-dandy, do-it-all machines to equally eager government users. Some universal checkout R&D programs were begun; however, calmer heads prevailed and the market trend that actually developed called for broader use of automaticity applied to specific weapon and space systems.

Systems took the digital approach and made broader use of the programmer/comparator for test control, sequencing, and evaluation.

A paradox is that today's automatic checkout systems really do not reflect the present level of the technology. New systems, practical but considerably more advanced in total capability, are on the horizon and will be employed during the next few years. Where the need exists, these newer systems will provide computer control and in some cases will be integrated with the systems to be checked, particularly in on-board checkout situations.

Integrated circuits, once advanced enough to permit mass production and lowered costs, will provide some impetus to system designers.

It should also be noted that as more and more systems go digital, automatic testing requirements will become less complex.

G. H. Thorne, a computer expert at Sperry Utah Co., points out, however, that although digital system costs will be reduced in time, test equipment costs will rise because of the steadily increasing demands for added capability, higher speed, and parallel operation.

The manufacturer's problem today is that he must develop flexible systems that can be tailored by modular selection to fit customer requirements. At the same time he must have many testing techniques at his disposal. As Frank Lynch, Nortronics vice president and manager of systems support, states the case, it's a matter of trade-off in the customer's mind. Costs must be weighed against technical feasibility, and the customer will not buy computer control if there is a less costly way to his job.

Predicting continuing expansion in the automatic checkout field, despite the problems, Lynch pointed to the vast, untapped market available within industry, particularly in the fields of maintenance and production control.

• **Success story**—A typical example of how a good but unsophisticated checkout system can be successfully exploited is Nortronics' Datico. Developed first for the Army, but never purchased in quantity, it was later employed as an interim checkout system for *Polaris* aboard the early fleet ballistic missile submarines.

The system worked well, was redesigned, steadily improved, and ultimately won a first-team slot. Two systems are used for each submarine. Later a third system was modified for use as fire control system checkout aboard the submarines.

More than 40 units have been delivered and the systems are scheduled for use on all future *Polaris* subs, including those of the United Kingdom. Datico may be used on the NATO surface fleet, if that venture should come to pass.

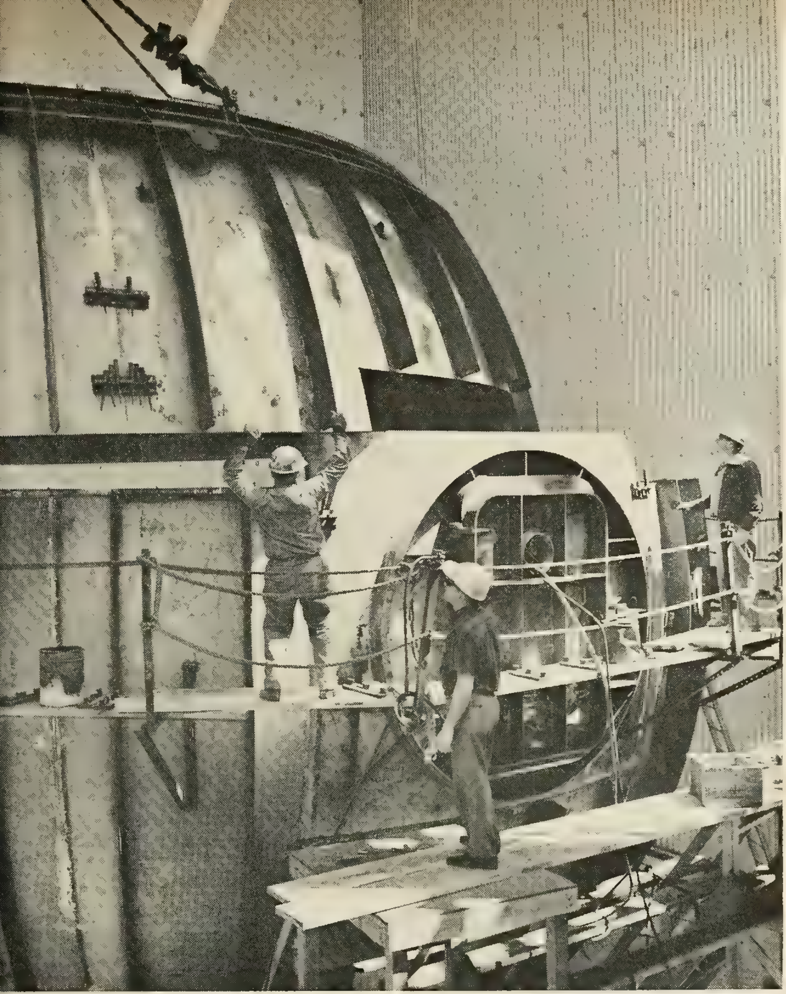
By the end of calendar year '63, $125 million worth of Datico systems will have been sold. The potential from FY '64 through '70 could total another $135 million, observers predict.

• **RIFT requirements**—Introduction of nuclear-powered upper stages into the U.S. space program, perhaps late in this decade, could usher in a most significant test and checkout market.

The equipment requirement for the *NERVA-RIFT* program now under way will evolve both from ground tests being conducted at the Nevada Nuclear Rocket Development Station and test and checkout concepts now being drawn up for *Saturn-Apollo*.

With *RIFT* envisioned as an upper stage for the *Saturn* to be launched from Merritt Island Complex 39, NASA officials point out that the stage will have to be compatible with *Saturn V* automated checkout techniques to keep within the space agency's objectives of standardizing programs wherever possible to handle different *Saturn* payloads.

With *Saturn* checkout compatibility in mind, similar stage checkout equipment at Nevada and at the launch site probably will be called for. NASA estimates that at least another $50-60 mil-



EARTH-ORBIT simulator being built by Douglas Aircraft at its Space Systems Center, Huntington Beach, Calif., will be one of largest space chambers in the Free World.

lion will go into the Nevada sites for stage test and engine checkout stands within the next few years. About $15-20 million of this will probably be spent for test and checkout instrumentation.

NASA's long-range plans at Nevada include what will no doubt be the greatest challenge for test equipment manufacturers—a complete environmental chamber for testing the entire *RIFT* stage.

NASA officials stress that this project is merely under consideration. There are no firm plans, and, they add, it is not even certain that it could be built.

The chamber itself would be huge—large enough to hold a 150-ft.-high, 33-ft.-wide stage—and have vacuum capability not only to evacuate the chamber to space-environment levels but also to deal with the expelled propellant.

"This would be really expensive," says one NASA official, "costing perhaps $60 million. However," he adds, "if we have confidence built up during the *RIFT* ground-testing program, a facility of this type would significantly improve reliability beyond a shadow of a doubt and certainly be worthwhile in light of the cost of the *Saturn V* booster."

At the Merritt Island Launch site, a nuclear assembly building will probably be required, located remotely from the major test areas. No funds for this project have yet been requested. Estimated cost for the facility where reactor and engine would be mated is about $5 million, including perhaps $½ million for instrumentation. The checkout would be at least semiautomatic here, NASA reports, with computer analysis of neutron flux levels.

Officials point out that the *RIFT* flight reactors will not be ground operated. They will have criticality checks and pump checks, but firings will be made only with non-flight models at Nevada. In flight, the nuclear stage will not be started until after first-stage operation.

Obviously, the continuing round of reactor test firings and subsequent stage tests at Nevada will require a heavy influx of remote handling devices. Most of these will grow out of experience built up in the Kiwi development program. As the flight test of these stages draws closer, it will cause proportional increases in the radiation qualification of components and entire subsystems, both in the payload and certain portions of the booster.

There is apparently little likelihood that NASA will ever use the test approach in which flight reactors are fired for short test bursts and then remotely mated to the launch vehicle. This reduces the equipment requirement at the launch site, but necessarily lends less conclusive proof that the vehicle will operate as programmed.

In any event, the nuclear assembly building at the launch site will be physically designed to retain most of the fission products in the event of an "incident" during criticality checks made here after safety features are removed. The safety devices, "poison wires" and control drum locks, will be replaced as the stage moves from the nuclear assembly building to the vertical assembly building for mating to the *Saturn* vehicle.

On the pad, additional anti-criticality checks will be conducted, as well as checks of reactor destruct systems, which will be developed with dummies during in-flight test program.

- **Environmental testing**—A stepchild of the Space Age, environmental testing is often unwanted, and certainly unloved. It nevertheless is well-fed and growing.

In spite of a hazy marketing picture, a large effort is being made to develop new and better equipment and find a place to sell it.

Estimates of the present and potential market—indeed, even definitions of environmental test equipment—cover a wide range. To further cloud the marketer's crystal ball, major projects are often spread over a number of contractors and manufacturers and cover periods of several years.

Space chambers and associated equipment, the major items in this market, offer about the only yardstick for judging its potential. Best (conservative) estimates of this part of the market appear to be in the neighborhood of $200-225 million over the next two years. Large systems—the so-called field-directed or field-constructed—will account for about $150-200 million. The smaller systems—chambers of 12-ft. diameter or less and costing from $25,000 to $1 million—will make up the balance of the market.

Well over $100 million has been invested in "large" space simulator facilities by private industry and government,

TOTAL MISSILE/SPACE ESTIMATED EXPENDITURES

(Forecast based on current funding Trend)

(Billions of Dollars)

	'62	'63	'64	'65	'66	'67	'68	'69	'70	Total
DOD										
MISSILES	8.2	8.4	8.3	8.3	8.3	8.1	7.9	7.6	7.4	72.5
SPACE	1.2	1.4	1.7	1.9	2.2	2.5	2.9	3.3	3.7	20.8
NASA	1.8	3.7	5.7	6.0	6.2	6.4	6.6	6.8	7.0	50.2
RELATED AREAS	2.3	2.7	2.9	2.9	2.9	3.0	3.0	3.2	3.3	26.2
TOTAL	13.5	16.2	18.6	19.1	19.6	20.0	20.4	20.9	21.4	169.7

ELECTRONIC TEST & CHECKOUT EQUIPMENT

(Estimated Expenditures for RDT&E and Production)

(Billions of Dollars)

	'62	'63	'64	'65	'66	'67	'68	'69	'70	Total
DOD										
MISSILES	.655	.670	.665	.665	.665	.650	.630	.610	.590	5.800
SPACE	.050	.075	.085	.095	.110	.125	.145	.165	.185	1.035
NASA	.090	.185	.285	.300	.310	.320	.330	.340	.350	2.510
RELATED AREAS	.070	.080	.085	.085	.085	.090	.090	.095	.100	.780
TOTAL	.865	1.010	1.120	1.145	1.170	1.185	1.195	1.210	1.225	10.125

according to a recent survey by a space agency authority. "Large" is defined as a chamber with a 13-ft. diameter or larger.

Facility costs vary widely—from $½ million to $30 million apiece, depending on versatility. The same NASA official estimated that a few facilities will cost between two and three times as much as the old ones. A projected facility, in fact, is expected to cost in the neighborhood of $100 million.

In a recent market appraisal for military Simulation Systems and Related Equipment (Fiscal Year '62) by GMP Reports, Inc., a division of Smith, Winters, Mabuchi, Inc., of New York, the field is described as offering ". . . a healthy, profitable $250-million market."

The report further stresses changes now occurring due to the highly competitive nature of the industry:

"In 1958 there were approximately 40 prime contractors in the field, five of whom received the major portion of award dollars. At that time aircraft simulation systems accounted for 85% of the market. Today, four of the five are not even in the top-10 bracket. There are over 131 companies now participating in this market, 98 of them having received prime contracts during FY '62. Aircraft simulation systems have declined to less than ⅓ of the total market, with dollars shifting over to the missile and space vehicle systems, space and solar simulators, submarine and sonar systems, radar systems and land-based weapon systems."

• **Growth too rapid?**—Some experts argue that things are moving too fast and that facilities are being built that are in some cases inadequate, and in other cases superfluous. John New of Goddard Space Flight Center, for instance, disclosed his belief that there already is an excess national capacity in big space chambers. He feels that there should be a pause and a review of the situation before proceeding further in this area. Other experts agree.

Nevertheless, plans are going forward for the biggest facility of them all to be built at the NASA Manned Spacecraft Center at Houston. NASA-Lewis (Plum Brook) is proceeding with plans for a 100 x 122-ft. chamber for nuclear propulsion (SNAP) testing.

Such government facilities—and government-funded industrial facilities—are getting heavy criticism on other fronts, too, especially from the independent testing laboratories.

Wyle Laboratories' Elmer R. Easton is particularly vocal about the situation. He says that government labs, contractors, and manufacturers all want "and will sometimes go to great extremes" to obtain as much government funding as possible to enhance their test capability. This, he says, is frequently with a knowledge of, and without regard to, existing capabilities literally down the street.

His not unbiased opinion is that such government funding of testing facilities can destroy either the market for the independent capability or the means of selling that capability in a competitive atmosphere, or both.

Easton's solution for part of the problem is the completion of a master directory of test capabilities. No such compilation now exists. The directory, Easton says, would create two immediate and specific effects: the quantity of new facility requirements would sharply decrease, and utilization of existing and new facilities would sharply increase.

Wyle claims to be the nation's largest independent testing company in the aero sciences. Billings for testing services are presently running around $8.5 million per year. Investment in test facilities, exclusive of land and buildings, is $5.2 million. During the past two years, Wyle invested $3.2 million.

On the other hand, there is a controversy as to whether private industry should have to invest in expensive environmental facilities. Statements have been attributed to NASA which imply that a contractor must have adequate testing facilities in order to get contracts. Whether this is true is a moot point. In any case, many feel that NASA should make its policy clear in this regard and should also survey and document existing facilities and their capabilities.

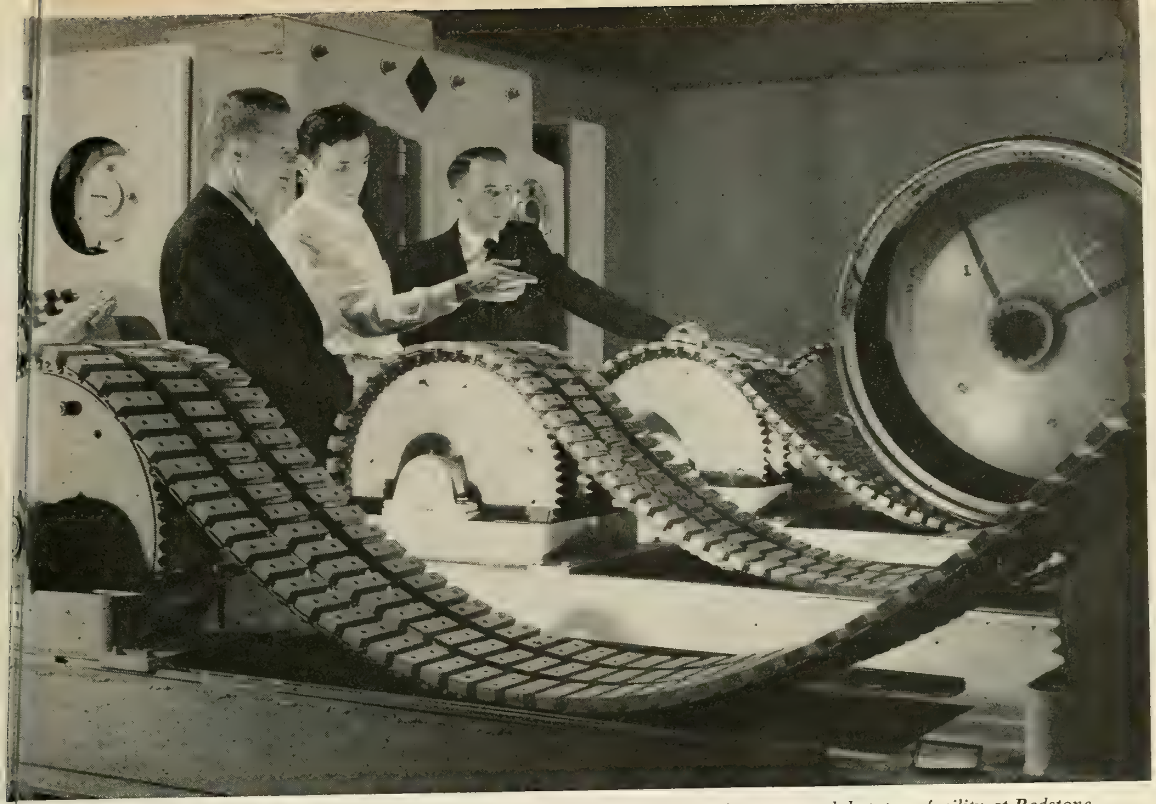
Considerable diversity of opinion exists concerning levels of testing needed to adequately simulate the effects of the environment. For example, M. P. Hnilicka, of National Research Corp. says that test needs should be determined "without regard for our technical and economic capabilities to provide whatever simulated environment may be required." If compromise is necessary, he says, it must be reached at a later stage.

Others agree that environmental checkout could be improved. If it were good enough, they say, many of the failures that have plagued the space programs might not have occurred. But the dissenters raise the eternal question of money. There doesn't seem to be any industry-wide agreement as to the optimum trade-off or portion of the program dollar that should be devoted to the environmental test program.

NASA-Goddard estimates that costs for its environmental testing program may range between 15 and 25% of total project development costs. As an indication of the magnitude this may represent, one recent satellite project cost 15 direct man-years of test effort.

To date, they say, the test programs have averaged less than ten percent of the irrecoverable cost of the spacecraft launch. In the case of *Thor-Delta*-launched spacecraft, this figure, prorated over a period of 10 years and 20 launches would amount to about $1 million per bird.

Does environmental testing pay off? Goddard has some impressive figures to show that it does. A recent review of scientific satellite failures detected in environmental test programs during 1962 shows that 114 failures were discovered in five satellites in the JPL test facility. Cost of these spacecraft exceeded $34 million, and all five later successfully performed in space. ■



MISSILE CARRIAGE specially designed by Allis-Chalmers is part of Army's automated betatron facility at Redstone.

EST AND CHECKOUT

Computers, Integration Top Trends

Digital computers getting urgent attention; NASA pushes for 'micro-electrical' devices; tougher environments sought

A GROWING DEMAND for more nd better environmental test and checkut is providing the spur for developnent of new ideas, techniques and hardvare.

Outstanding results of Space Age ressures are trends toward computer ontrol of checkout systems, integrated ircuitry to reduce system size and exend capacity, and the creation of more severe environmental conditions within test chambers.

- **Integrated circuitry**—Extensive use of microminiaturized integrated circuits in test and checkout equipment will strongly affect new equipment design. It unquestionably will lead to more manageable equipment on the ground and greater use of on-board test and checkout for manned spacecraft.

In flight, the weight savings inherent in use of these devices can be applied either to increase spacecraft payload, to increase reliability through redundancy, to increase use of self-checking circuitry—or simply to allow more data devices to go aboard. The latter application may lead to inclusion of more adaptive types of telemetry and data-processing equipment on board spacecraft and satellites, thus reducing the immense data flow which now swamps many project engineers.

On the ground, it will mean that mobile test equipment which nows rolls up to a payload in two vans may soon occupy only a single carrier. Overcrowded launch block houses, lined with racks of equipment, may also enjoy the benefits of widespread use of reliable integrated circuits. In subsystem and system testing, it should make it possible to employ many more dynamic tests to replace static tests. Its use in data-processing equipment, with its thousands of repetitive circuits, should cut significantly the space and power requirement of many of the larger ground-based systems.

Perhaps one of the most important new terms in NASA now is "micro-electrical devices." This term connotes NASA's belated but welcome push to extend microminiature techniques throughout the entire black box, beyond just the electronic circuitry. "Once you get down to low power levels you must look at the whole thing as a problem rather than just the electronics," says Dr. Albert Kelley, Director of Electronics and Control in NASA's Office of Advanced Research and Technology.

Kelley asserts that NASA is very

SUN'S rays will be simulated in space chamber being built by Honeywell for NASA-Goddard. System includes 127 powerful arc lamps.

anxious for industry to look hard at the power-supply and power-conditioning equipment associated with electronics. These devices make up most of the weight of the package, he says, and should be handled as a system problem by systems engineers, familiar with all the equipment in the box, with an eye towards reducing them in size and power.

"In effect," says Kelley, "we need an integrated package to replace the integrated circuit." Here particular attention must be placed on the traditional weak link in integrated electronics—the inter-connection problem.

NASA is also anxious to standardize integrated circuitry, to develop a periodically up-dated building block classification approach to the space agency's use of these circuits. "We want to stop engineers from personalizing their circuits; stop the unnecessary tailoring of electronic design."

As for use of thin-film circuits in on-board test and checkout equipment, NASA feels that the devices will have improved radiation resistivity. They believe they possess inherent advantages in that, if affected, they may suffer degraded performance rather than total disability.

- **Motorola standardizes**—Motorola Inc.'s Military Electronics Division is presently combining its continuing research in integrated electronics with the preliminary analysis it has performed for the Air Force on "Design Criteria for Automatic Checkout Systems."

One of the great problems concerning checkout equipment, said one official at the Scottsdale, Ariz., facility, is its high cost-to-support ratio. The price of support equipment in general now approaches 50% of the total cost of a weapons system, he declared, and reduction of this cost is of prime importance.

A second and related requirement, he pointed out, is standardized test and checkout equipment.

"The functional characteristics of a family of test assemblies could be used in evolving a series of test systems which would satisfy the test requirements of the various generic weapon-system types. These functional blocks could consist of circuit components such as readers, counters and memories," he suggested.

With utilization of standardized circuits, he said, an investment comparable to that being applied to particular transistors and potential integrated circuits for the *Minuteman* ICBM could yield extremely high reliability.

Such standardization could mean writing off one of the higher tooling expenses for integrated circuits—particularly for monolithic circuits. Using large numbers of such circuits could bring about comparatively low circuit costs.

- **Checkout**—The increasing complexity of prime weapon or space systems dictates the configuration of checkout equipment. Because it becomes increasingly difficult to perform manual sequencing in the time allotted, the need for automatic testing is increasing.

Due to their inherent speed and versatility, there is a growing urgency to employ digital computers as the central checkout programmer in new systems. Such systems, industry leaders believe, will dominate during the next five-year period.

For the following five years, however, many experts predict a growing trend toward self-organizing systems that would in all probability be almost totally integrated with the system to be tested.

Others expect the ordinary computer to remain for a much longer period in checkout systems. E. B. Quinn, of Sperry-Utah Co., foresees a greater use of repeated sampling of data in an effort to detect changes in circuit parameters. He also predicts a greater role for failure-effects analysis in symptomatic interpretation during testing.

A problem inherent in any scheme based on sophisticated computer control is that of programming. It is difficult to find a computer specialist who is also well versed in checkout, and of course the reverse is also true.

Trainable systems might also reduce the present software problem, some experts believe.

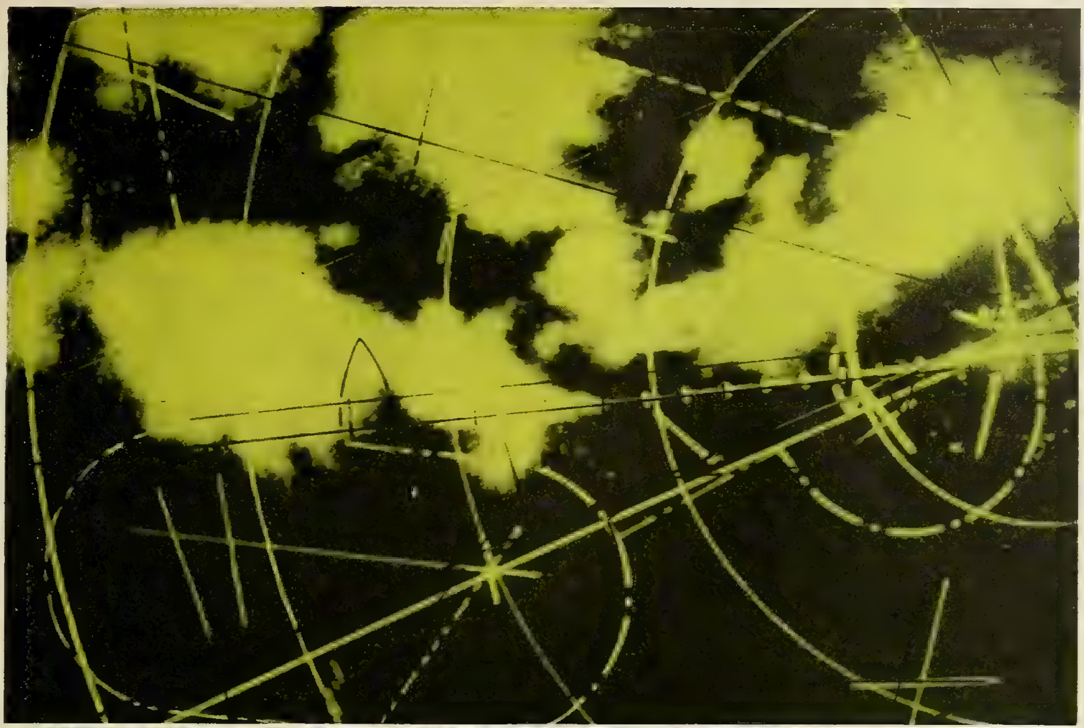
As technology moves ahead into on-board checkout systems, particularly for long unmanned flight, self-diagnosing and self-healing systems will come to the fore. Also, the self-organizing system may be advantageous, since its design embodies the concept of generalization—that is, with such a system, the loss of a given component would not necessarily result in a system failure.

- **Between extremes**—There are two opposing schools of thought with respect to on-board test and maintenance. One holds that the astronaut should be given an oscilloscope and simple measuring devices and allowed to perform his own test and checkout. The other wants a fully integrated, heavily redundant system capable of continuous monitoring and fault isolation to the module level.

There is, of course, a large group whose philosophy lies somewhere between these two extremes. Honeywell experts take such a position, but they are working on a somewhat different checkout concept.

First, they oppose the module-by-module or subsystem-by-subsystem test approach because they believe the interplay or relationship among various circuits is not fully recognized.

Their approach involves use of the known transfer functions within any system as a means for determining degradation or failure. They would monitor but not interrupt operating systems, and hence would introduce no external stimulation into systems. In addition, they feel that their concept would lend itself to failure prediction in time to



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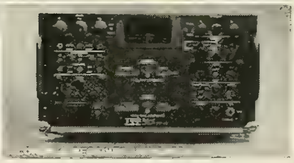

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VIBRATION NEWS

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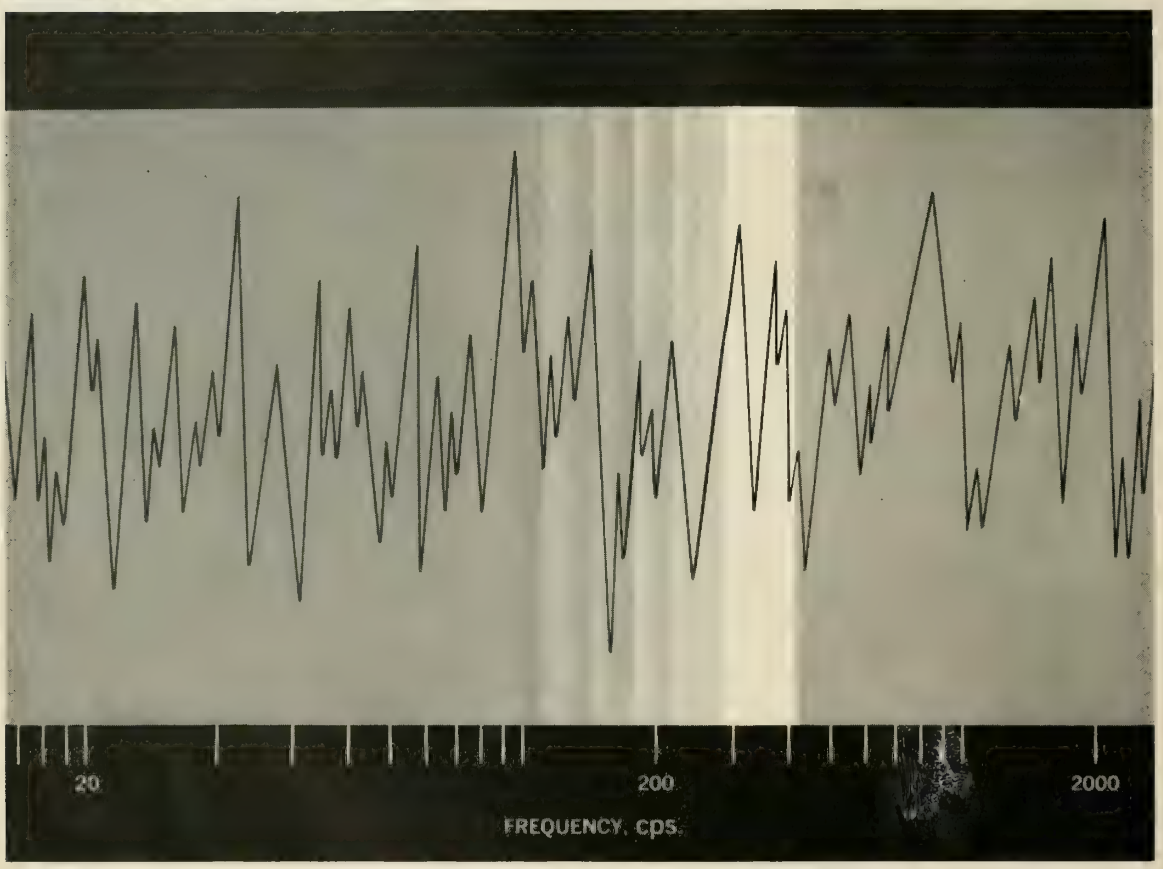

MB introduces SWEEP RANDOM— a new, low-cost method of random vibration testing

MB Electronics now offers industry the Narrow Band SWEEP RANDOM system. This new technique in random vibration testing is designed to create stresses and accelerations at all levels similar to those provided in the more expensive wide band random test. It is easy to operate and inexpensive enough to be used with the smallest simulation test system in general use today.

The new MB SWEEP RANDOM method reduces the total force required for wide band testing by sweeping slowly over the frequency range with an intense narrow band excitation, in contrast to the low acceleration density excitation of the wide band test.

This results in a reduction of from one third to one half the force ratings heretofore required for simulated random vibration tests. Considerable cost savings are also realized with this new MB system.

The MB SWEEP RANDOM system is ideally suited for testing components and sub-assemblies of systems which might be given a final qualification test by wide band random techniques.

For more detailed information on the SWEEP RANDOM system write to MB Electronics, 781 Whalley Ave., New Haven 8, Conn.

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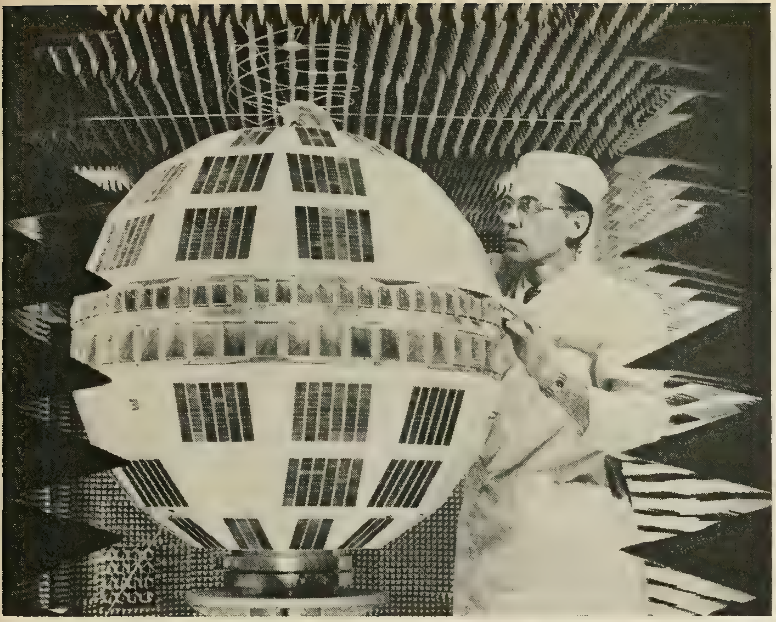


IN ANECHOIC CHAMBER at Bell Telephone Labs, Hillside, N.J., engineer inspects model of Telstar satellite. Room is lined with foam plastic to absorb radio energy.

perform corrective maintenance during a planned maintenance period—rather than under the duress of forced repair and replacement after failure.

A few manufacturers are considering two unique new checkout concepts.

One involves the development of an infrared pattern or map from the normal IR emissions of circuits and the system as a whole. This signature of a properly functioning system would then be compared periodically with new readings. Proponents believe that any abnormality would be revealed by the entirely passive technique.

The second approach is similar in that RF radiations would be sought as a method of fault checking. Changes would be detected with a highly tuned probe receiver. Such an approach actually would sense spurious emissions above some established threshold. Those studying the approach feel it could detect faults not detectable by conventional methods. It would, however, be limited to detection of incipient component failure.

● **Unmanned payloads**—Several trends in test and checkout of manned payloads and man-rated boosters are also manifested in the unmanned payload philosophies which are evolving. There are differences in the test approaches, however, particularly in their degree of automation.

While prime contractors on the unmanned programs will no doubt introduce more automation into their tests as vehicle complexity grows, the pace will be far less frantic than in the manned programs. Checkout will for the most part be sequenced semiautomatic operations with a considerable amount of manual override. More emphasis on sequential functional-block type programs is expected.

In the test gear for the *Orbiting Geophysical Observatory*, engineers at Space Technology Laboratories report stimulating, monitoring, and observation is done both semiautomatically by a punched-tape storage program and automatically with a general-purpose digital computer, lending flexibility for expanded test needs. Data requirements of 64,000 bits per sec. in some conditions make manual data-processing impossible, they report.

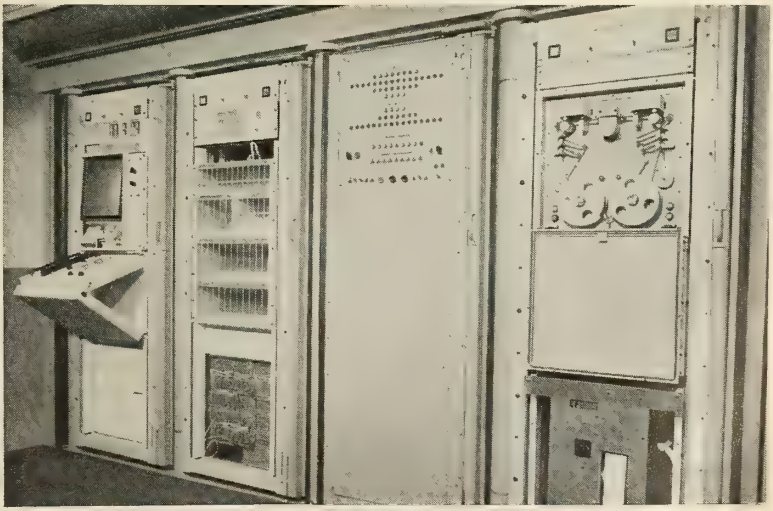
STL also is making considerable use of mobile system-test-van concepts on both Air Force and NASA unmanned craft and reports that major improvements in test capabilities have resulted. The mobile van, operating through an RF link, follows a spacecraft from initial assembly through environmental and systems tests and up to final prelaunch check. In this manner, engineers report test station-spacecraft interactions are small and constant and the effect of the test equipment on the spacecraft operation is minimized.

With the exception of certain special stimulation and measuring gear, use of the mobile van essentially keeps the spacecraft area clear. Subsystems of the van parallel those of the spacecraft.

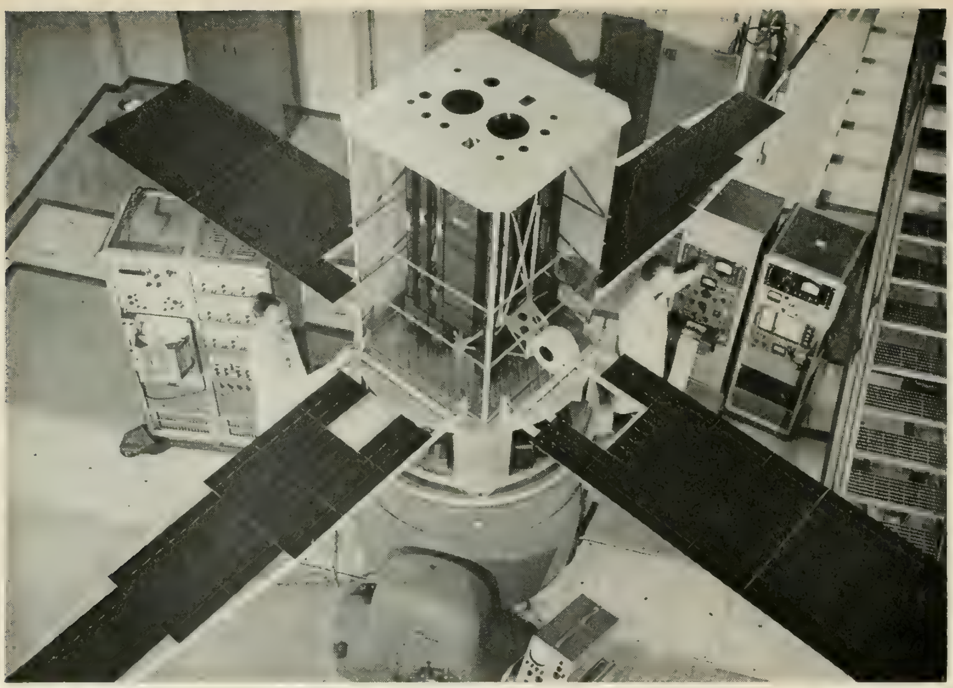
● **Whole-craft testing**—Difficulties with programs such as *Ranger* will no doubt lead to more spacecraft specifications calling for space simulator testing for extended periods for entire vehicles. The *Nimbus* contract includes this type of requirement.

The entire *Nimbus* spacecraft, minus solar paddles, will undergo extensive operating checkout in a 39-ft.-high vacuum chamber. Prototype models, mounted on a gas bearing with ±3 degrees of freedom inside the chamber, will be continuously operated for a 39-day simulated flight. Flight models will be run through a 21-day flight. Every two hours, the system will be interrogated via the RF link.

Inherent in the design of *Nimbus* was a requirement that it be compatible with an air-bearing setup. Balance problems within a chamber are severe and are demanding considerable industry at-



DATICO MARK 412 (also known as MOTS, for Module Test Site) was built by Nortronics Div. of Northrop for checkout of Polaris submarine fire control, guidance.



MOCK-UP of advanced satellite on 28,000-lb.-force vibrator at Goddard. Vibrations can be either random or sine. Force is put in by amplifier joined to vibrator.

tention, and the use of air bearings complicates vacuum problems.

There will be more testing of components, subsystems, and entire nonflight systems to levels beyond flight specs early in the program; feedback to reliability engineers will enable them to continually update confidence levels and pin-point weak links throughout vehicle design stages.

For interplanetary probes, much of the test and checkout philosophy will no doubt grow out of initial NASA studies on *Voyager* being conducted by General Electric and Avco Corp.

- **Further plans**—Other unique test requirements are evolving. It's reported that NASA's *Pioneer* solar probe, slated for 1965, will require extremely low ambient magnetic fields within the spacecraft. NASA says there are only a few facilities in the nation where tests in this environment can be performed. New facilities are said to be going in at NASA's Goddard Space Flight Center and at STL.

The NASA-Hughes Aircraft Co. *Surveyor* remotely controlled lunar-landing spacecraft will also be in for some unusual testing. NASA says a complete flight model will be taken out to the desert and run through a complete checkout by means of the Deep Space Instrumen-

SOLAR simulation components will be mounted on support structure shown here in one of NASA's giant new space chambers being constructed at Goddard Space Flight Center.

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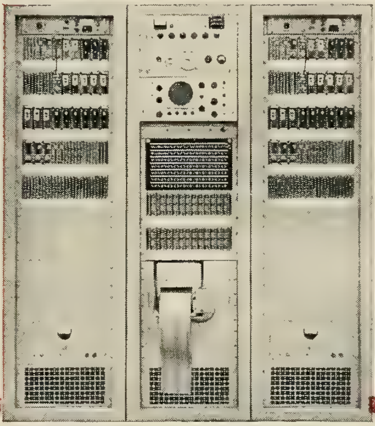

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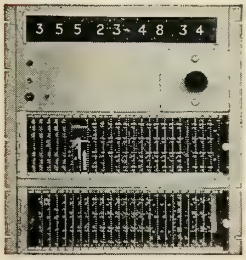

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Model 6200 converts input serial time codes to time-of-day display.

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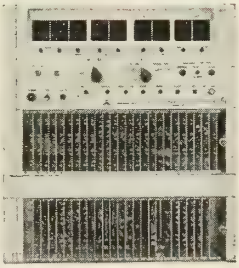

Model 6420 TIME CODE TRANSLATOR/GENERATOR...operates as Translator and/or generator...synchronizes time code generator to input serial time code...no interruption of output on loss of input signal.

Model 6620 Timing terminal unit...provides basic module for standard terminal function assemblies...can be assembled to provide any necessary terminal, signal conditioning or conversion functions...assemblies available: AGC amplifiers, demodulators, neon drivers, high level amplifiers, balanced line drivers, galvo amplifiers, relay drivers.

A new 48-page handbook of the most commonly used time code formats has been compiled as a handy reference for instrumentation engineers. For your free copy write to

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tation Facility spaceflight operations setup. The same personnel who will run the flight mission will run the ground tests. "We will check out the command systems, instruments, data links, and the people," NASA stated.

In Congressional testimony this year, NASA also revealed that it was proposing "another essential improvement which would benefit the unmanned lunar and planetary programs—a replacement spacecraft prelaunch checkout station at Cape Canaveral."

As spacecraft complexity grows, particularly lunar and planetary orbiters and landers, extensive prelaunch and postlaunch checks must be pulled on the on-board instrumentation. NASA stresses that this proposed prelaunch checkout must be carried out through "exactly the same type of RF communications and telemetry systems which are to be used in flight."

This essentially will be the function of the proposed station. NASA says it will have deep-space network instrumentation compatible with the higher frequency S-band operations to which the DSIF will move next year (M/R, Sept. 17, p. 41). Display consoles will present information for quick analysis by the project director in pre-launch go/no-go decisions.

NASA reports that the station will be fitted with a small parabolic antenna to maintain the two-way communications link both before and after launch. Officials also stress that the station will service only requirements peculiar to spacecraft. Launch-vehicle tracking and telemetry will continue to be provided by the standard Atlantic Missile Range instrumentation.

- **Environmental test needs**—Environmental testing has other growing pains. These center mostly on matters of philosophy, standardization, and realistic specifications. Even though the state of the art is expanding rapidly, most of the technical experts feel that there are few requirements that cannot be met with existing knowledge and refinements.

One great unfilled need, however, stands out: a simulated zero-gravity environment. No one has the answer to this one. The best suggestion so far is a free-fall chamber carried aloft by a balloon and dropped. Such a technique, however, would afford little working time.

There are negative aspects that worry some industry experts. Up-dated, realistic test specifications are badly needed. Trained personnel who can intelligently use modern simulation facilities are in short supply, and there is some feeling that academic programs leading to degrees in environmental engineering are now a necessity.

Trends in the industry are poorly defined: the basics are apparent but beyond that there is no good, solid future direction. Certainly, future systems will have to be more sophisticated—it will be necessary, for instance, to simulate lunar and planetary environments. Exactly what this will require is somewhat nebulous, since the environments must first be determined before they can be simulated with any degree of authenticity.

Special facilities will be needed for testing ion engines and other propulsion devices. Nuclear vehicles pose special problems that will require advances in the state of the art.

Space chambers may eventually be even bigger than those presently existing or planned. Their ultimate size, some experts say, may approach 200 ft. in diameter. There is a continuing effort to reach higher vacuums. Many observers argue, however, that the present state of the art is sufficient for the immediate future, and that effort should be directed to refinements and improvements: better pumping and sealing methods, and better instrumentation, calibration, and controls.

Scaling has been proposed as one way to reduce testing costs of the larger sys-

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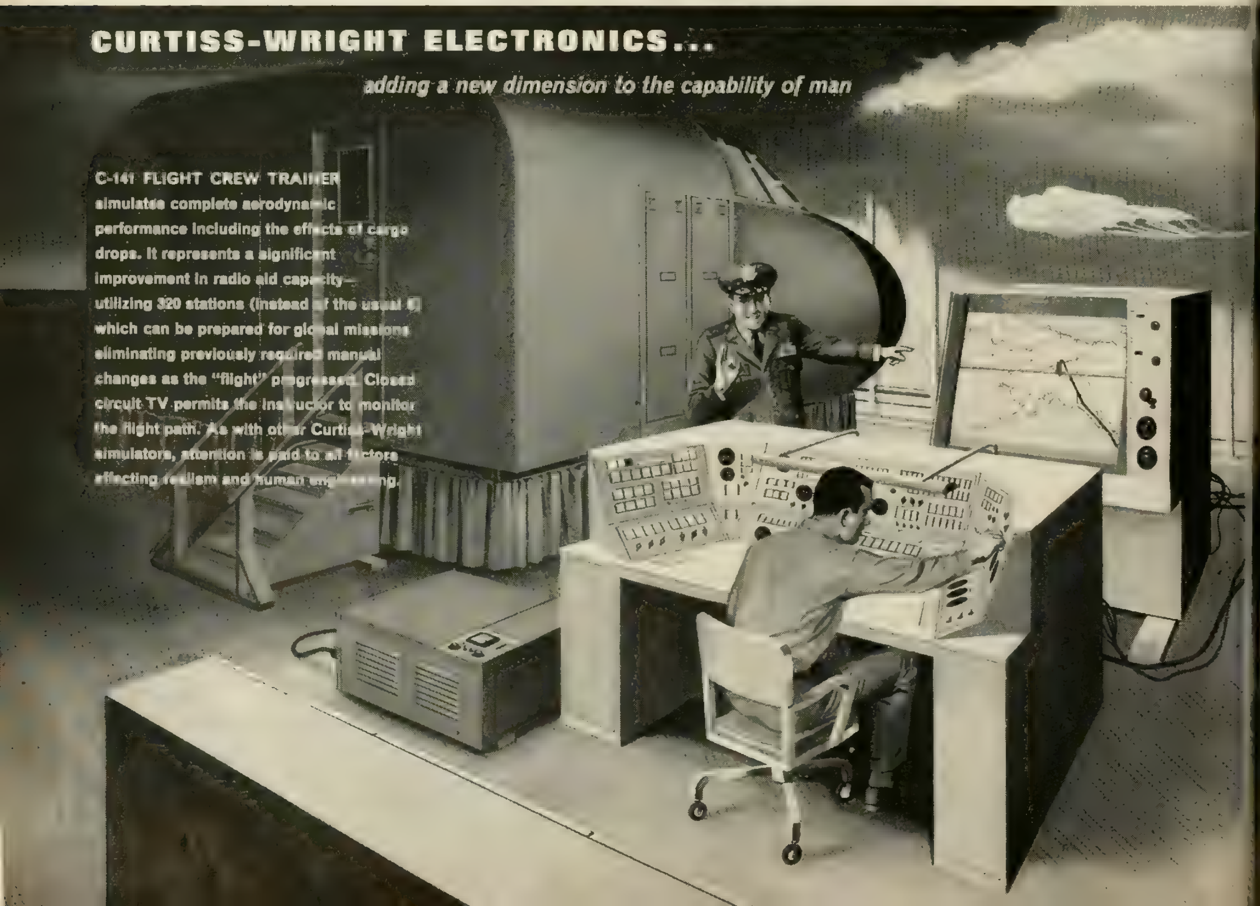

CURTISS-WRIGHT ELECTRONICS...

adding a new dimension to the capability of man

C-141 FLIGHT CREW TRAINER simulates complete aerodynamic performance including the effects of cargo drops. It represents a significant improvement in radio aid capacity—utilizing 320 stations (instead of the usual [illegible]) which can be prepared for global missions eliminating previously required manual changes as the "flight" progresses. Closed circuit TV permits the instructor to monitor the flight path. As with other Curtiss-Wright simulators, attention is paid to all factors affecting realism and human engineering.

tems; detailed investigation of such techniques may be pursued in the future. Other methods and procedures for cutting costs will have to be investigated as space programs grow more advanced and complex.

- **APL program**—The Environmental Test Laboratory at Johns Hopkins University's Applied Physics Laboratory is simulating the environmental conditions of Earth-orbiting satellites and satellite flight hardware, and is researching space materials for prolonged survival in Earth orbit.

Basing their calculations primarily on present and past programs, APL scientists anticipate that a large number of orbit-simulation tests will have to be performed on flight hardware in the next 10 years. The state of the art is such that adequate general environmental tests can be performed in this field. The present limitations, these scientists say, are imposed by the speed of set-up and operation of the existing space simulation facilities. There are specific problems in achieving:

1. Rapid changes from one test thermal plateau to another without thermal shock to the unit and without interrupting other test conditions.
2. Non-thermally conductive suspension systems which are easily used with bulky and heavy objects.
3. Easily changed through-ports containing large numbers of copper wires, thermocouples, RF connections, liquid lines and quartz windows that will be reliably leak-tight without pre-test checks on the test chamber.
4. Cold shrouds that can be controlled from liquid nitrogen temperatures up to + 150°F with a reasonably small overall temperature gradient.
5. Rapid shut-down and start-up procedures to enable a sick test unit to be removed, repaired and quickly returned to the test conditions.

APL's effort to obtain maximum reliable lifetime for a satellite in an Earth orbit requires that the temperature of the satellite be stable or at least predictable. Although much preliminary work has been done toward developing a paint or other coating which will retain its absorptance/emittance values in the space environment, a completely satisfactory material has yet to be found.

Evaluation of the various materials must either be done by elaborately instrumented flight tests or by accurate laboratory simulation of the characteristics of the space environments which cause the degradation. This requires an ultra-high vacuum and accurate solar simulation as a minimum.

Discussing only this one apparently simple problem, a spokesman said there should be ultra-high-vacuum (10^{-12} torr or better), medium-size (20-100-cu.-ft,) space chambers for component testing and evaluation of materials for use in the space environment.

These should be convenient and economical to use and be capable of thorough instrumentation—thermocouples, electrical, optical, mechanical motion, and radio frequency feedthroughs. They should be capable of the desired performance without requiring either liquid helium cryopumping or bakeout unless contaminated by a test object. A chamber requiring either of these items is expensive, and difficult to use. In some tests, its use may be possible.

A simple and accurate solar simulation source which is capable of operating unattended for several days is required. It should match the Johnson curve as closely as the carbon arc does, or better, and be as simple as some of the small mercury arc lamps.

Current studies of the simulation of exotic environments of space—such as radiations and micrometeoroids—should continue at their present rate, but the programs for more adequate simulation of the major space environments need to be increased, the APL official asserted, so that some of the simple relationships of the reactions of materials and systems on Earth vs. in space can be compiled. ■

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PROJECT IN POINT:

this C-141 crew thinks it has just completed an equipment drop

Simulation reflects the ultimate in the *application* of science and technology. It is the electronic bridge from research to reality. At Curtiss-Wright, electronic simulation systems orient men and machines to missions for many military and industrial programs.

Project in Point: Under contract to the Air Force, Curtiss-Wright today is producing a fully digital flight crew trainer that matches the high performance characteristics of the new Lockheed C-141 turbofan transport. This flight simulator is the first to use a general purpose, all-digital computer.

The C-141 is being developed as a "10-year aircraft" with built-in capability to accommodate newer power plants as they become available. This flexibility in the giant transport's design is matched by the Curtiss-Wright simulator. Because it is fully digital, the simulator can be updated easily to reflect performance changes at minimal expense and down-time.

Advanced activities like this have created immediate opportunities at Curtiss-Wright Electronics Division for solid state circuit designers, digital computer programmers and others experienced in the application of real-time digital computation to the most challenging problems in simulation.

For complete information, please write Mr. E. Gene Kelly, Manager of Professional Placement, Curtiss-Wright, Electronics Division, East Paterson, New Jersey. An equal opportunity employer.

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Military Asks More of Contractors

Aerospace ground equipment suppliers study automatic test sets for such advanced systems as Titan III, Polaris, Minuteman

TEST AND CHECKOUT systems for civilian space vehicles tend to follow a different development course than those of missiles. The divergence will be less marked in the case of military space systems.

This is becoming apparent as the Air Force continues development of *Titan III* and other military space system building blocks pending the appearance of well-defined military space missions.

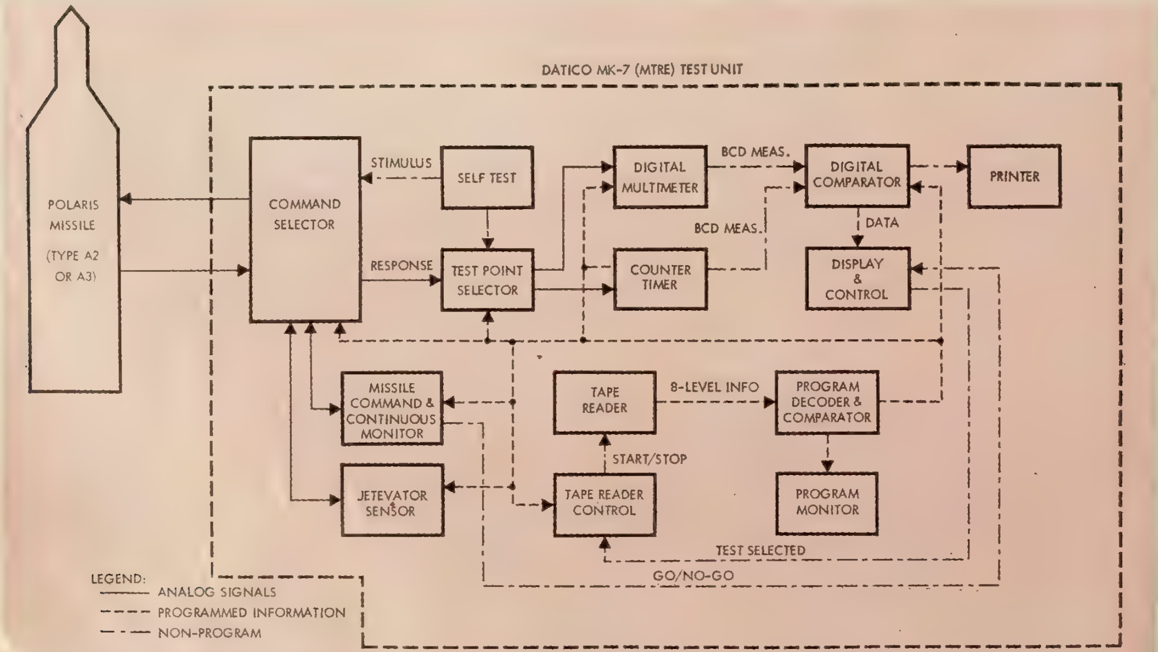
Military systems of all sorts share a requirement for quick reaction and the necessity of operating without college-degree-bearing crewmen. At present, USAF intends to man military space launch facilities with crewmen having background and training similar to that of ballistic missile crewmen.

The greater size and complexity, and the necessity for man-rating of planned military space launch systems inevitably raises points of difference in maintenance philosophy and the related design of test and checkout equipment. Also, there remains a variety of approaches to testing and maintenance among missile programs.

To get a look at some of these differences and the reasoning behind them, MISSILES AND ROCKETS contacted military and contractor personnel associated with *Titan III*, *Polaris*, *Minuteman*, *Nike-Zeus* and *Pershing* as representative of the most advanced programs in their fields. M/R also talked with aerospace ground equipment (AGE) companies who are looking at new technology for future automatic test sets.

One important force in the industry is a drive by government to get more complete testing done in the factories. Government fears that contractors view launch site testing not as a redundant check, but as a key phase of vehicle qualification.

- **Front-line checkout**—New development work on test and checkout equipment is largely directed toward making digital computer-based test sets usable by military forward echelons. In a few cases, computer-based sets are in service at the maintenance depot level but have not yet appeared in the more rugged operating environment. The core of most Automatic Test Equipment is



BLOCK DIAGRAM shows functions of DATICO Mark 7 for checkout of A2 and A3 Polaris missiles aboard Lafayette-class submarines. Other DATICO units perform similar testing on earlier George Washington- and Ethan Allen-class subs.

still the tape-fed programmer-comparator.

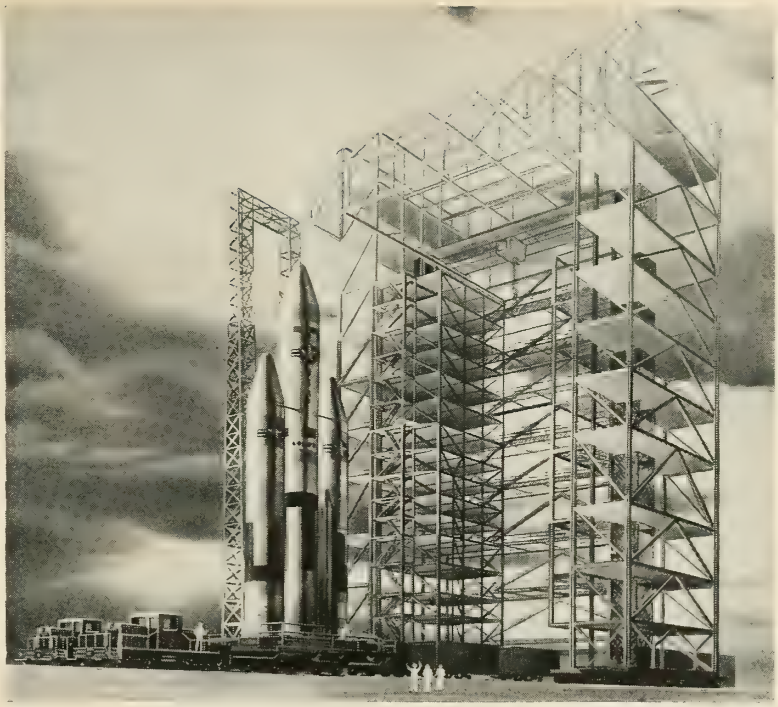
In more advanced technology, researchers are looking at the parallel logic, perception-like, adaptive computer. In test and checkout applications, an adaptive computer-based set would not be halted in mid-program by the detection of a fault as is the case with programmer-comparators. It could circumvent the fault and continue checking subsystems around the detected fault. It might also be capable of adjusting to new failure rate data to reduce test frequency for components with low rates. Lower test frequency puts less time on components prior to launch, and thus contributes to reliability. Adaptive computers are somewhat self-healing, and a test set based on one could not be put out of source by a single component failure.

In *Titan III*, the only military space vehicle now figuring in plans for manned applications, the need for quick response and fast re-use of the launch pad has dictated development of the Integrated-Transfer-Launch complex to prepare the vehicle at one location and transfer it to a site up to four miles distant for launch. The I-T-L concept, plus the modular vehicle design used to give *Titan III* flexibility, has produced an unusual approach to test and checkout equipment design.

- **Single system impossible**—Since payloads cannot be specified while missions are ill-defined, and since even booster configuration can change with mission and payload, a single system of test and checkout gear cannot be designed. Thus, the spacecraft and the solid-propellant first stage in the *Titan III* system are being considered separately from the liquid-propellant core of the booster for test and checkout purposes. Equipment interfaces between booster and spacecraft are held to a minimum because the concept includes a variety of spacecraft, some not yet specified.

There are to be separate spacecraft and booster control centers in the Vertical Integration Building (VIB), within which complete systems will be assembled for transportation to the pad. Any interfaces between spacecraft and booster checkout systems will be here, where the versatility of the human crew can be used to solve problems without reliance on long-lead-time items.

Titan IIIC will be a four-stage booster with two United Technology Center one-million-lb.-thrust solid-propellant rockets used as the first stage and three storable-liquid-propellant stages in the core vehicle. The core vehicle can be fired separately, as *Titan IIIA*. When the solids are not used, associated test sets also can be left out of the system.

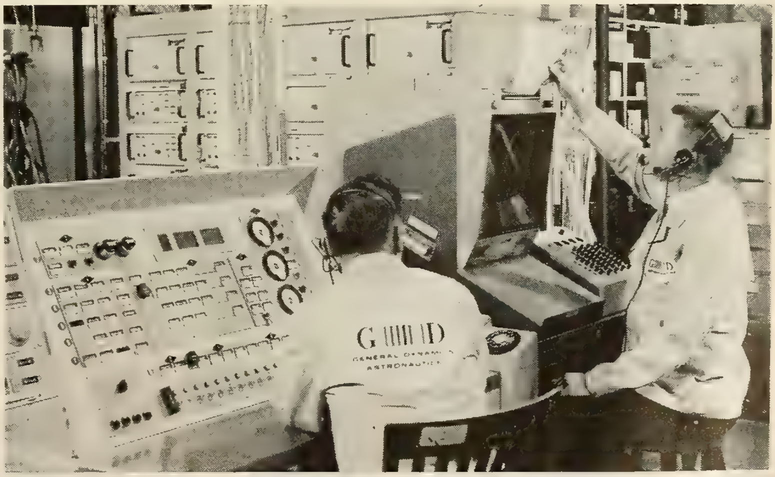


THE INTEGRATED-transfer-launch (ITL) complex is an integral part of Air Force's Titan III standardized space launch system.

Most of the AGE, including the automatic test sets, is mounted in rail vans, connected to the vehicle and drawn along with the vehicle transporter to the pad. There it is housed in concrete buildings at the foot of the booster to protect it from the exhaust blast at launch time. It is anticipated that there will be two vans for spacecraft AGE and two for booster AGE.

Since *Titan III* will lift more than one type of spacecraft, there will be a variety of spacecraft AGE vans in the complex to be plugged in as needed. A faultless complete systems test takes only about 30 seconds of pad time, since the test sets remain connected from the time the system leaves the VIB until launch.

As part of the drive to get modifica-



TECHNICIAN pulls printed instructions for isolation of missile malfunction in demonstration of new FAST1 troubleshooting technique for complex missile systems developed by General Dynamics/Astronautics, San Diego, Calif.

tion and testing operations off the pad and back into the factory, the Air Force's Space Systems Division intends to provide a factory-like environment in the VIB where it is hoped an irreducible minimum of this work can be done. Immediate availability of pads for military mission launches is a priority goal in the program aided by these steps to cut down the number of operations there. A pair of 28-volt data-transmission sets carry signals between the AGE vans and the control center. Most data will move by land lines.

• **Redundancy**—It is not anticipated that very much time will be available for correcting faults detected on the pad in such missions as satellite intercept and inspection. To get high mission reliability the Air Force must avoid pad maintenance operations. This is done by making very large elements of the system redundant.

For instance, if there is a failure in the control center it is possible to shift control immediately to a separate control center. This is not the case in the event of a failure in the van-mounted AGE or in the vehicle itself.

To deal with this possibility, it is planned to ready a substitute at the same time to meet the launch schedule. With four vehicles in the VIB, one in the Solid Motor Assembly Building and two on the pad, it would be possible to have seven in an advanced stage of preparation to guarantee at least one clean countdown. The other part of the effort to achieve mission reliability is a component reliability program. Redundancy within subsystems is not a major part of the *Titan III* concept—though it is present where necessary to man-rate the vehicle.

A condition imposed on contractors developing test and checkout gear for *Titan III* by Air Force Space Systems Division was that the state of the art should not be pushed in these systems. More than 70% of the ground checkout equipment is adapted from that of *Titan II* ICBM. The wide use of 28-volt dc electrical system in *Titan III* is proving to be a big advantage because of the long experience acquired with these in aircraft electrical systems.

• **Titan checks**—Naturally, the test and checkout problem is sensitive to changes in vehicle design. An example is seen in the number of procedure steps in the pre-launch flight simulation tests for the whole Martin *Titan* series of missiles and boosters. There are 600 steps for *Titan I*, which burns liquid oxygen, 380 for *Titan II*, which burns storable liquids, and 430 for *Titan IIIC* with its additional storable liquid stage and its solid-propellant boosters.

These tests are conducted by an automatic Vehicle Checkout Set (VECOS) with provisions to isolate faults manually. It verifies functioning of the flight control system, propulsion, and malfunction detection system (MDS) when one is installed. The MDS is designed as a kit for manned missions to provide the crew with in-flight information about malfunctions and, in some critical cases, to automatically initiate an escape operation.

The VECOS has special circuitry to assure that the check-out equipment is disconnected from the rest of the system during launch. A pair of solid booster simulators small enough to be carried in suitcases represent booster parameters in tests of the launch control circuitry. A problem being faced in the *Titan III* program is the development of satisfactory ways to check out a control system with thrust vectoring by secondary fluid injection.

The Air Force has made no attempt to get any degree of universal application from test and checkout equipment for military space systems. Since it must be anticipated that *Titan III*, if it becomes operational, will fly many missions, there is no need to find other applications for the equipment to get a fair return on its cost. Martin engineers think that in the long run it will be

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cheaper to use simpler specialized gear that will be more reliable.

Already beginning to appear in *Titan III* are self-checking systems that provide a direct indication of malfunction without extraneous checkout equipment. This arrangement is expected to come into its own when test and checkout operations must be applied to spacecraft after a long time in a parking orbit and before the commencement of the final mission phases.

The alternative would be elaborate telemetry to permit trouble-shooting at ground stations. This probably would more than offset any weight saved by eliminating self-checking provisions.

- **Zeus replacement**—The *Titan III* practice of replacing the complete vehicle if final test and checkout reveals a fault is curiously echoed in *Nike-Zeus,* a quite dissimilar system. Contractor personnel often speak of *Zeus* in the past tense, but there is still good reason to hope that it will find a place in the *Nike-X* system along with the *Sprint* missile. The nature of the anti-ICBM mission and the kind of system devised to perform it provide a test and checkout environment quite different from that of other missile/space systems. Again, the need for fast reaction is the ruling basic requirement.

Zeus complexes are designed with the missiles emplaced in "farms" of silo-type launch cells. The decision to replace a whole missile if a malfunction is detected is based on the conclusion that all the warheads in the farm should be de-armed for personnel safety if maintenance work or extensive trouble-shooting is to be done on-site. This would entail loss of a large part of the *Zeus* complex's capability to react quickly to an alert. As it is, the time required to replace a missile is comparatively short and involves only that missile.

Missiles account for only a small part of the total cost and complexity of an anti-ICBM complex. Massive and sophisticated electronic systems make up a much larger part, and the vital test and checkout equipment for these is designed to very different requirements. It would be difficult to replace most of the functional subsystems of the huge radars. Since each large fixed electronic installation will command a large number of missiles, it seemed necessary and economical to develop a large automatic system capable of isolating the fault to the drawer-module level in a short time.

The 40-foot *Zeus,* being relatively portable, is to be checked by a self-contained mobile set shared among the missiles in the farm. The final part of the check is an all-systems test that amounts to a rough simulation of flight, commanded and evaluated first by a tape-fed programmer-comparator, and then by actual command guidance radio transmission.

It is also intended that the mobile test set should be used in the complex's First Repair Area, where it can isolate faults with slightly more precision. Each stage of the missile is divided into four or five subsystem functional sections. A failed section can be replaced in the complex and the missile can be put back in the farm, but it is not intended that the bad section should be repaired in the complex. The new radars of the *Nike-X* system are not expected to alter the *Zeus* missile test and checkout system very much if *Zeus* remains a part of the system.

- **Toward universality**—The concept of "universal" test sets for use on a wide variety of rockets is seldom discussed seriously in connection with military systems. The number of missiles in a military system is large enough to provide ample utilization of a specialized system. Furthermore, a set which approaches the universal application criterion usually requires a general-purpose computer and rare skill levels to operate.

However, the history of a system

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which is highly adaptable, if not quite universal, is instructive. The system is Datico, made by Nortronics Division of Northrop Corp. It was developed in 1956 as a test set for communications and radar equipment and has been evolved over the years for a wide variety of applications. Its most famous application is as the submarine-based test set for the *Polaris* Fleet Ballistic Missile System. Test sets made by other manufacturers have compiled similar records of adaptability. Notable are the Bendix GJQ-9, the Autonetics BASE system, and RCA's APCHE and MAPCHE systems.

Datico did not form a part of the *Polaris* system in early planning. It had been intended to use a computer-based system called ACRE (Automatic Checkout and Readiness Equipment), designed by prime contractor Lockheed Missiles and Space Co. Unfortunately, ACRE proved to be slightly beyond the state of the art at that time, and the Navy had to find a substitute on short notice to meet crash schedules.

It selected a Datico Type 001 test set, despite the fact that it had been designed for a relatively undemanding fixed-base environment, and modified it for the *Polaris* job in 26 weeks. It was natural that shortcomings were discovered in the harsh demands of submarine operations. One of the most serious was the noise of stepping switches, telephone-type relays, and clattering readout printers. Silence is necessary in submarines since sound remains the best way for an enemy to detect a submarine, and this failing was soon remedied in later versions.

The first Datico for *Polaris* was known as Type C. Component by component, it has evolved through the Mark 3 Missile Test and Readiness Equipment (MTRE) to the Mark 7, the Mark 412, and the Mark 414, until no element of the Type C remains in recent gear.

- **Package approach**—The factor that has made it possible to adapt Datico to submarine operations, improve it, and keep it compatible with improved versions of the missile is a design philosophy that divides components into functional packages according to their role in test and checkout operations. Improved packages can be substituted for current ones with a minimum of modification to the rest of the set.

Northrop Corp.'s Nortronics Div. runs a continuing component-development program from which improved packages can be derived and offered to customers. Thus the buyer can have what amounts to a custom-tailored version of the system. The concept works because any measurement can easily be converted into an electrical signal.

In the latest Lafayette-class *Polaris* submarines, a Lockheed-developed integrated system called TRACE is used which includes the Datico Mark 7 MTRE. The earlier Datico systems operated in three modes; standby, test, and operate. As part of the TRACE system, the Mark 7 is reduced to the test mode in which it operates continuously with test stimuli always supplied to the missile and response presented to the operators. It can simulate the fluid flow rates of the Liquid Injection Thrust Vector Control System used in the second stage of the *Polaris A3* and has brought a ten-fold reduction in the time to complete a test cycle. Its components have been mounted in highly shock-resistant door-and-post installations.

- **Module test set**—The Mark 412 and the Mark 414 are not part of the TRACE system. The former is also known as a Module Test Set (MOTS) and is used on Lafayette-class subs to check the Mark 84 Fire Control System, and the boat's two guidance systems. It can test up to 1,400 modules on 14 digital and analog systems. The Mark 414 is for depot testing of electronic components down to the replaceable spares level.

Datico was originally funded by the Army in an attempt to develop a universal checkout system for use with six tactical missile systems. However, while this R&D effort was in progress, specialized checkout systems were developed for each of the weapons systems. Thus, while feasibility was proved for the use of Datico, at least at the depot level, the effort died with proof of feasibility.

A new program was begun in March 1962, with RCA as R&D contractor under an initial $5 million award.

Present goal of the program is to develop an MTE (Multi-sysem Test Equipment) capable of performing complete checkout of four missile systems now in development plus future field weapons.

The basic MTE will first be applied to *Mauler*. Following this it will be used with *Shillelagh*, *Lance*, and *ADS-70* (*FABMDS* follow-on).

About $7 million has been spent to date (FY '63 funding is $8.8 million). The basic system will be carried in three air transportable helihuts—two electronic and one for hydraulic test. The system employs a digital computer for control and uses mylar magnetic-tape programming. The basic or general purpose MTE is operated at division level in the area support concept.

A "contract-team" vehicle, using only those portions of the basic system necessary to check out a particular missile, will be used in the forward areas.

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Subsystem deliveries are now in progress and should be completed this fall. The system development and test is scheduled for completion by February, in time for a first marriage and checkout of the *Mauler*.

- **Programmer-test station**—The mobile programmer-test station for Army's Martin *Pershing* 400-mi. ballistic missile is another line in the spectrum of test and checkout equipment. Faced with the most destructive environment, the Programmer Test Station has been run through the rugged tank course at the Aberdeen (Maryland) Proving Ground to verify its ability to function after a fast run over bad terrain. When in position in a forward area, the PTS is analogous to a complete blockhouse. Subsystem test and checkout and an all-systems simulated flight test are only two of the operations it must perform. It must also pre-set the inertial guidance and launch the missile.

Pershing electronics are mounted in huts. The huts and the launcher can be fixed in place or removed for air transportation but ordinarily would remain atop the XM-474 tracked vehicles. The PTS shares its vehicle with a gas-turbine power unit that supplies all the electrical power needed by the *Pershing* battery and also supplies bleed-air to the PTS air conditioning unit.

There normally are four of the tracked carriers in a *Pershing* battery and in the typical order of march the PTS is on the third, behind the warhead carrier and the launcher carrying the body of the missile. The fourth vehicle carries communications equipment. Like the rest of the *Pershing* systems, the PTS can be removed from its tracked carrier for air transport in a Vertol CH-47 helicopter or a larger aircraft.

Systems test and checkout and flight simulation are conducted by a relatively conventional programmer-comparator. The PTS hut contains a digital computer but its role in the forward area is only to set the inertial guidance system of the missile. The *Pershing* test set provides a go/no-go readout and can isolate malfunctions down to the major replaceable section. Spares are ordinarily kept at the battalion level, but the four missile batteries in the battalion are capable of independent operations up to a distance of about 100 miles, in which case they would probably carry spares with them. It would also be possible to replace a failed section by airlift.

The division of maintenance responsibility between the battalion's service battery and the general support unit at field army level is not rigid. The battalion is supposed to have a maxi-

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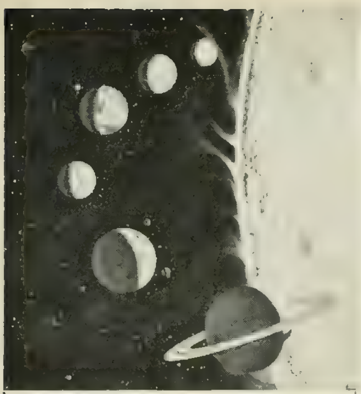

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SPACE AND INFORMATION SYSTEMS DIVISION

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mum of self-sufficiency, but actual division of maintenance responsibility for failed equipment will depend largely on the tactical situation.

The general support unit has a systems test station and a component test station which are used in conjunction with a PTS. The CTS can isolate a malfunction down to the throwaway card module level. The computer in the PTS, which is not used as test equipment in the forward area, is used in the rear area to supply guidance test inputs permitting the other equipment to trouble-shoot the missile guidance system.

- **FASTI**—The test and checkout business has been characterized by much development of components and techniques independent of any certain application to a vehicle. One interesting innovation of this sort has been developed by General Dynamics/Atronautics and has been tested to some extent on *Atlas* ballistic missiles. It is called FASTI (Fast Access to Systems Technical Information) and would be used in conjunction with ordinary test sets to speed up and improve the trouble-shooting process after first detection of a fault. FASTI can isolate simple and complex malfunctions in an average of 15 minutes. GD engineers estimate that this would amount to a time-saving of 95% for the *Atlas*.

As part of the trouble-shooting process, the system draws all needed material and personnel requirements, safety precautions, and down time estimates from a complete tech data library on microfilm. Ordinarily, handbook research to collect this data makes up a large part of the time spent in remedying missile system faults.

FASTI is developed for an application by using engineering data to make time-and-function-oriented logic diagrams and translating these to Boolean algebra equations that are stored in high speed computers. Every logically possible malfunction can be included, and its effect on the operation of the system can be analyzed. Sequences of checks or "isolation paths" are identified for every possible malfunction.

All the necessary information for trouble-shooting and repair is microfilmed and filed in an order appropriate to a particular operational status such as standby, countdown, commit, abort, and manual operation. Every system indicator and corresponding microfilm display is assigned an index number representing a particular abnormal indication.

When the appropriate index number is inserted in the retrieval machine, it delivers the correct display on a screen within six seconds and prints a copy within 20 seconds. If more than one display is needed to pinpoint a malfunction, each display calls forth the index number of another until the set is complete.

The displays are presented in the order of need. The first presents information on potential emergencies and safety considerations along with advice to hold, trouble-shoot, continue, or abort. It also indicates checkpoints at which to investigate the situation. When the second display is delivered, it will contain more detailed instructions and more indicators to be checked. In addition to providing further instructions or checkpoints needed, the third and final display includes a schematic of the circuit containing the fault and lists of the personnel skills, tools, test sets, and spare parts required; specific repair procedures; and an estimate of the time needed to complete the repair.

The timesaving offered by FASTI means increased weapon system availability. It can also cut waste of spare parts in trial-and-error trouble-shooting and can prevent the consequences of hasty action in an emergency.

Characteristic of the technology sometimes involved in factory test and checkout functions are the large linear electron accelerators used to X-ray missile solid propellants for flaws and voids. The largest of them is a 25-mev machine now going into service at Hill AFB, Utah, to check the propellant grains of *Minuteman* missiles. It replaces a 2-mev machine and is expected to cut the time required to inspect a *Minuteman* from 316 hours to 13 hours because of the faster exposure with the more powerful accelerator. The big "linac" was made by Varian Associates.

- **Betatron detector**—A highly automated Betatron X-ray system, designed and built by Allis-Chalmers, West Allis, Ill., is in operation at Redstone Arsenal, Ala., for flaw detection in solid propulsion units. The system eliminates the need for photographic film—findings are recorded on a roll chart, eliminating the tedious X-ray film processing steps.

Accepted by the Army Missile Command's Test and Evaluation Lab after successfully pinpointing known flaws in missiles, the automated betatron now inspects *Nike-Zeus* and *Pershing* Motors. The ac unit cuts large motor inspection time by 66%.

The system uses a 25-million-volt betatron capable of penetrating 64 inches of solid propellant, a carriage that automatically rotates the specimen, and an analog strip recorder. The line on the strip recorder indicates the size of the flaw along with its presence.

The Allis-Chalmers system cost the Army around $200,000, installed, and is the first dynamic unit supplied by the firm out of 15 inspection stations supplied in the past. ■

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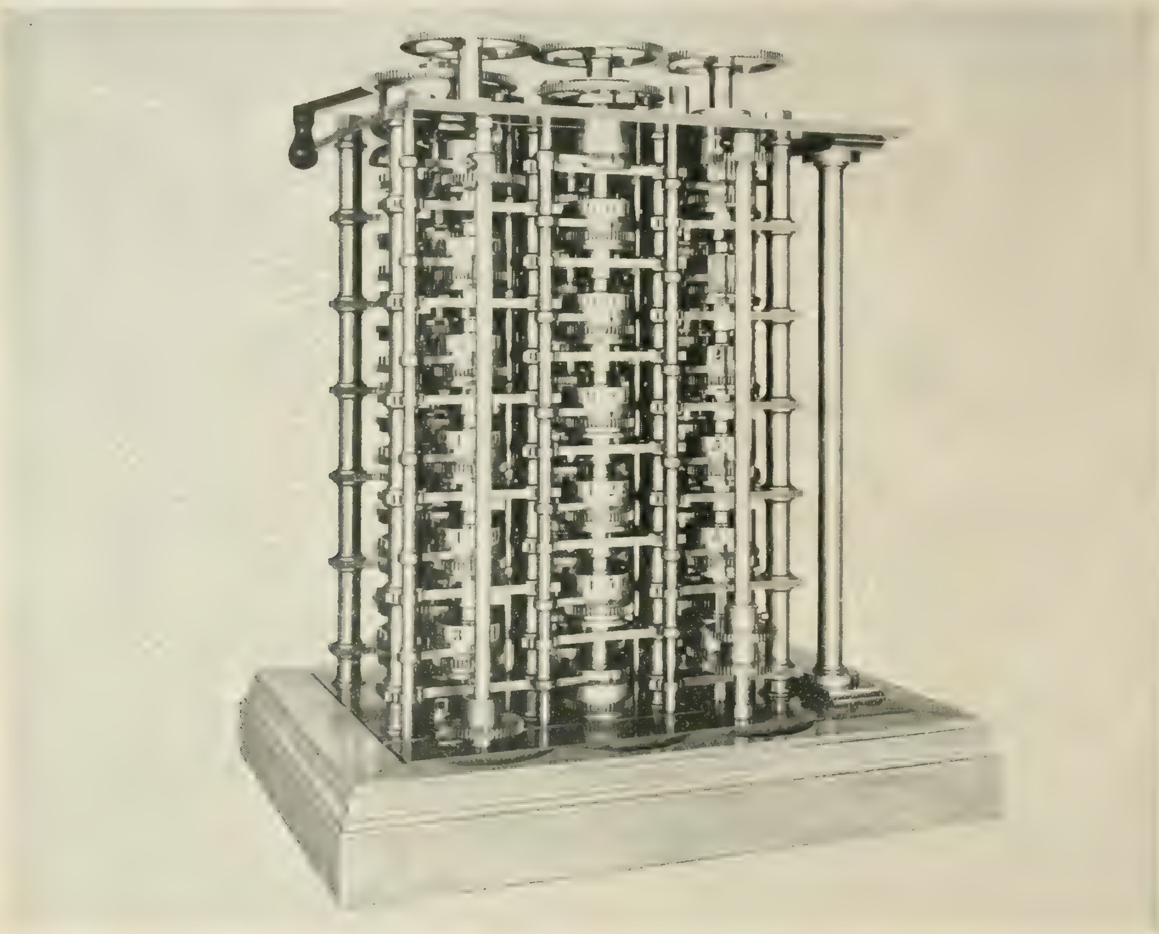
FROM DIFFERENCE ENGINE TO COMPUTER



Part of BABBAGE'S DIFFERENCE ENGINE (circa 1830) which was designed to calculate functions through finite differences. Since it had the disadvantage of a "fixed program," Babbage devoted the rest of his life to a "universal" analytical machine. (British Crown Copyright, Science Museum, London)

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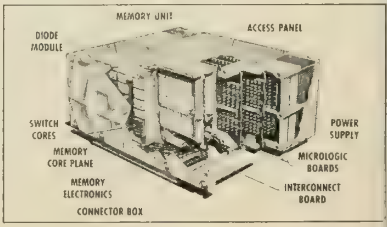
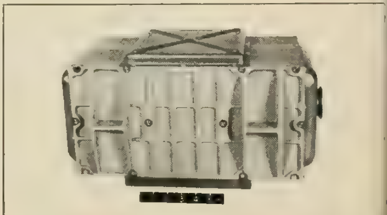
MAGIC—The first lightweight general purpose airborne digital computer to use molecular electronics—was introduced recently by AC. The function of the airborne computer is to handle computations and actuate vehicle controllers for guidance and control of the missile, space vehicle or aircraft. In a popular sense, the MAGIC computer serves as the brains of the total airborne guidance system.





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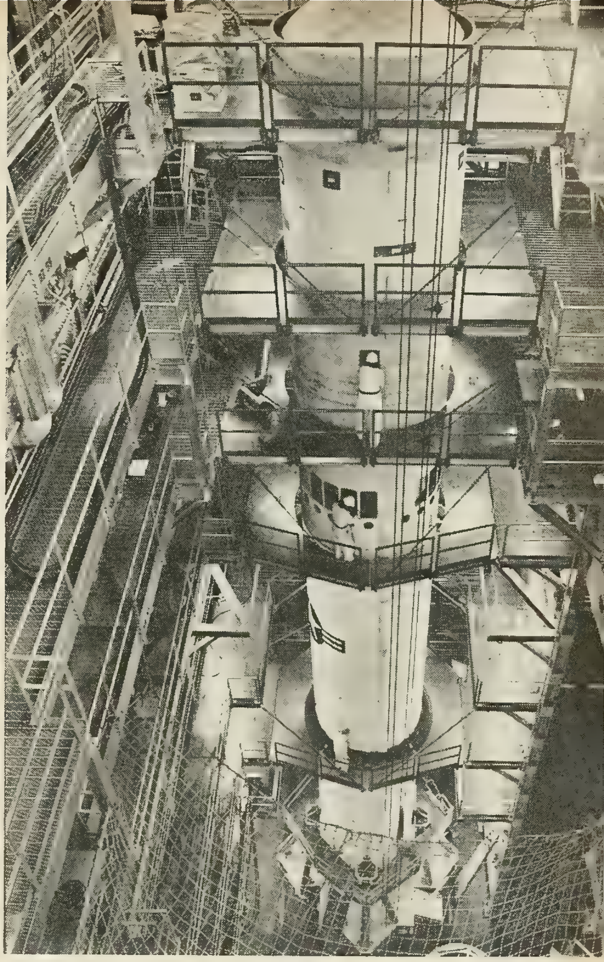
NASA Plans for Future Hinge on Three Programs

Events in Titan II/Gemini, Saturn/Apollo and Atlas-Centaur/Surveyor projects will shape concepts; a survey of each program



VERTICAL test stand for Gemini spacecraft's Titan II booster vehicle is checked over at the Martin Co.'s Baltimore division.

THE ROLE AND DESIGN of future test and checkout systems, on the ground and on board, will largely depend on the success and shortcomings of the support systems for *Titan II/Gemini, Saturn/Apollo,* and *Atlas-Centaur/Surveyor.*

Checkout concepts for NASA's next three large-vehicle space programs are based on two principal needs: to standardize manufacturer's and launch area checkout procedures and equipment and to minimize countdown requirements and time consumed at the pad.

The introduction of man into spacecraft has created a new requirement. In the past—and particularly with missiles—the checkout approach was Fail/Go; with manned craft it must be Fail/Safe. Finally, there is an increasing trend toward giving the pilot more control, particularly with respect to escape during the launch phase. This, together with the need for in-flight monitoring will press the development of on-board checkout in future systems.

Gemini Pioneers On-Board Monitoring

FIRST SPACE VEHICLE in which on-board malfunction monitoring will be available is NASA's two-man *Gemini.* And the first manufacturer's vertical checkout of a major launch vehicle will be performed on *Gemini's Titan II* booster prior to its transport to the launch facility.

Of equal significance is the fact that the Martin Co., launch vehicle prime contractor, will employ test equipment and facilities at its Baltimore plant identical to those at Cape Canaveral. To minimize engineering bias and make certain the most is obtained during factory and launch area checkout, separate test and checkout teams will be used—not design or fabrication personnel.

Extensive use of on-board manually-controlled abort systems in Project *Gemini* will give NASA its first major insight into the operational capabilities and needs of astronauts that affect design and degree of inflight test and checkout equipment.

While the astronauts' ability to make repair will be limited (major access to repair modules on *Gemini* is from outside the pressure cabin, the opposite of the situation in *Apollo*), Project *Gemini* will put the pilot a step nearer his traditional role than did Project *Mercury.* Easy access to system modules from the outside will speed launch site checkout. NASA says the *Gemini* craft should require about 2½ months testing at the Cape prior to launch. *Mercury* checkout at the launch site generally took 6-7 months.

Major modifications to the Martin Co.'s *Titan II* launch vehicle include a Malfunction Detection System (MDS) with an associated cockpit display which allows the crew to monitor and evaluate possible abort development by more than one indicator, and take corrective action independent of ground evaluation and command. Considerable system redundancy built into the *Titan II* launch vehicle and *Gemini* controls provides the "maintenance" or corrective capability for the crew.

Also a factor is the additional crew reaction time attributable to use of slower reacting hypergolic fuels in *Titan II* as compared with the rapidly reacting propellants used in *Mercury-Atlas.*

In addition to the considerable degree of takeoff on-board monitoring equipment, astronauts will also be able to check the condition of Lockheed's venerable *Agena-D* vehicle upon rendezvous in orbit.

- **Booster monitor**—In *Gemini*, overall mission success and crew survival probabilities are improved by a combination of the MDS (all circuits are redundant); completely redundant electrical, guidance, flight control, and Stage I hydraulic systems; and an ejection seat escape mechanism actuated manually by the crew.

Martin Co. engineers say the MDS system evolved through analysis of every component, subsystem, and system of the launch vehicle to determine all critical failure modes, their effect on the system and the vehicle, and the probability of catastrophe. After summing all failure modes and systems effects, malfunction parameters were established.

As currently conceived by Martin, the MDS sensing system will monitor and display data including: 1) Stage I and II oxidizer and fuel tank pressure—displayed by an analog meter on spacecraft instrument panel; 2) Pitch, roll, and yaw overrate—displayed by a single light on the panel. The light will come on at filtered pitch and yaw rate of 4 deg./sec. during Stage I operation, 10 deg./sec. during Stage II, and at a roll rate of 12 deg./sec. during either stage operation; 3) Stage bolt firing will also be a light display; 4) Stage I combustion chamber pressure—display light will actuate if pressure in either chamber falls below minimum after ignition but before staging signal; 5) Similar procedures are included for Stage II chamber pressure; 6) A low-voltage light display is also incorporated; 7) Command—a single light will come on either by command from the blockhouse via hardline before launch or on receipt of a command destruct signal by the launch vehicle command receivers.

Martin says the MDS is a composite of bi-level (0 and 28v dc) and analog signals, which originate in redundant sensors and are then routed through the launch vehicle interface, terminating at indicators in the spacecraft. The analog sensors are connected in independent, parallel circuits, individually routed to the spacecraft. The bi-level sensors, in turn, are connected in series; consequently, the contacts of both sensors in the redundant pair must be closed simultaneously before a signal is initiated.

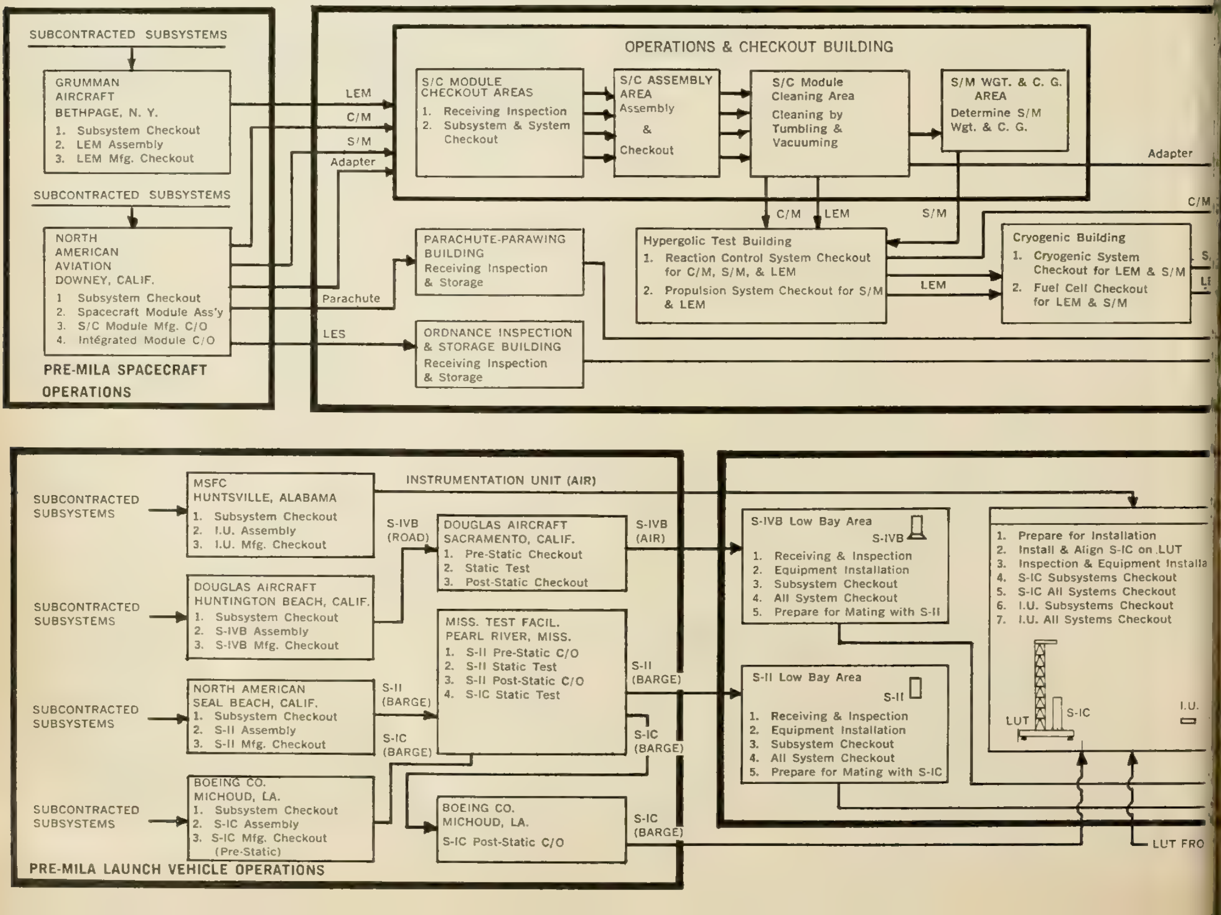
- **Ground checkout**—*Titan II Gemini* will be launched from Complex 19 at the Cape. A comparison of equipment used shows that of the 208 AGE control points, 143 involve *Titan II* equipment developed for the R&D system, 33 involve *Titan* modified and 32 *Gemini* peculiar control points.

The ground instrumentation system at the launch complex consists of a telemetry ground station, data-recording equipment, signal conditioning, power monitor and control, time code distribution, control console, and associated patching and cabling. Data will be acquired by both RF telemetry link and umbilical landline.

Checkout philosophy for the *Titan II* launch vehicle calls for a decentralized approach using specialized test equipment for each major flight subsystem. Each functions with relative independence from the other, but all are coordinated by the launch control equipment during the countdown phase.

In general, checkout systems are

Saturn-Apollo Checkout and Assembly As Presently Planned by NASA



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OPERATIONS & CHECKOUT BUILDING
S/C MODULE CHECKOUT AREAS
1. Receiving Inspection
2. Subsystem & System Checkout
S/C ASSEMBLY AREA
Assembly & Checkout
S/C Module Cleaning Area
Cleaning by Tumbling & Vacuuming
S/M WGT. & C. G. AREA
Determine S/M Wgt. & C. G.
Adapter
C/M
C/M
LEM
S/M
PARACHUTE-PARAWING BUILDING
Receiving Inspection & Storage
ORDNANCE INSPECTION & STORAGE BUILDING
Receiving Inspection & Storage
Hypergolic Test Building
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S-IC Post-Static C/O
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PRE-MILA LAUNCH VEHICLE OPERATIONS
S-IVB Low Bay Area
S-IVB
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2. Equipment Installation
3. Subsystem Checkout
4. All System Checkout
5. Prepare for Mating with S-II
S-II Low Bay Area
S-II
1. Receiving & Inspection
2. Equipment Installation
3. Subsystem Checkout
4. All System Checkout
5. Prepare for Mating with S-IC
1. Prepare for Installation
2. Install & Align S-IC on LUT
3. Inspection & Equipment Installa
4. S-IC Subsystems Checkout
5. S-IC All Systems Checkout
6. I.U. Subsystems Checkout
7. I.U. All Systems Checkout
LUT
S-IC
I.U.
LUT FRO

manually operated at the Baltimore complex. AMR will employ an automatic sequencer.

Launch control is maintained with a Master Operations Control System (MOCS). Time coordination is provided by the MOCS. Also it will display the state of readiness of all systems at any stage of the checkout.

The Martin-Baltimore facility will be employed for all final horizontal and vertical testing, including subsystem verification tests and combined systems acceptance tests.

Developers hope through use of the vertical test facility to establish a realistic vehicle test signature which can be effectively used at the Cape for later comparison with launch-pad test data.

The vertical test facility includes the test building and the stand, capable of accommodating two *Gemini/Titan II* vehicles at one time.

Measuring 150 ft. in height, the test building includes an Airborne Systems Functional Test Stand (all subsystem testing) on the first floor, a transfer room on the second, and a master control room on the third floor. The latter contains a spacecraft simulator checkout-coordination set to satisfy interface problems of system integration and testing. In addition, the center is comprised of the radio-command guidance checkout set, instrumentation remote-control console, and the MDS checker console.

As the program now stands, McDonnell Aircraft Corp. will build 13 vehicles—12 operational and one employed for extensive space chamber systems testing.

First booster will be installed by Martin at Baltimore within the next few weeks. After three months of testing, the first modified *Titan II* will be transported to the Cape, where it again will go through a complete vertical checkout.

Saturn-Apollo Presses State of Art

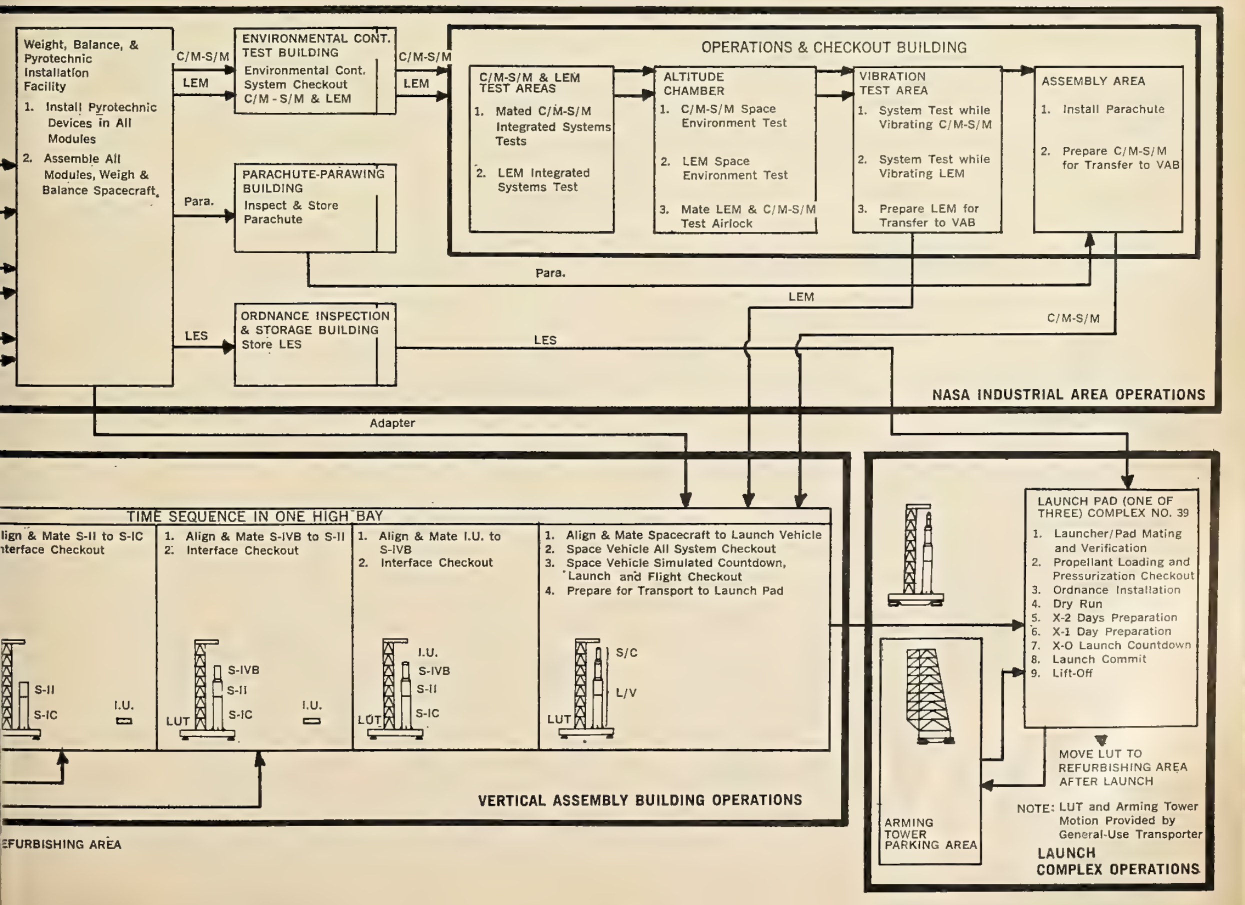
WHEN *Saturn V-Apollo* takes off from its Merritt Island launch complex headed for the Moon, it will have gone through the U.S. space program's most extensive, highly automated, and far-ranging test and checkout procedures.

The investment in checkout facilities and equipment for this booster-spacecraft combination will be so great that it will be virtually certain to influence design of all post-*Apollo* ventures.

If any single U.S. missile or space program can be said to be pushing the state of the art, *Saturn-Apollo* is it. This is not true in the traditional hardware sense—in fact, very little, if any, new advanced t/c equipment is required. There is, however, much to be done in the software aspects, particularly the intelligent and efficient use of computers and the exact assessment of what the man-machine relationship should be in handling a fully automated vehicle of this size and complexity.

Though portions of the test and checkout scheme are already under way, final decisions as to the type and number of checks performed on the final vehicle—both on the ground and in flight—will evolve gradually, building on the experience gained from a range of programs far wider than is generally known.

Not only will there be important inputs from Project *Gemini, Saturn I* and *IB,* and early Earth-orbit *Apollo* flights, but NASA also has a ready ear for significant contributions from the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ALTITUDE CHAMBER
1. C/M-S/M Space Environment Test
2. LEM Space Environment Test
3. Mate LEM & C/M-S/M Test Airlock
VIBRATION TEST AREA
1. System Test while Vibrating C/M-S/M
2. System Test while Vibrating LEM
3. Prepare LEM for Transfer to VAB
ASSEMBLY AREA
1. Install Parachute
2. Prepare C/M-S/M for Transfer to VAB
Para.
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C/M-S/M
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Adapter
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nterface Checkout
1. Align & Mate S-IVB to S-II
2. Interface Checkout
1. Align & Mate I.U. to S-IVB
2. Interface Checkout
1. Align & Mate Spacecraft to Launch Vehicle
2. Space Vehicle All System Checkout
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S-II
S-IC
I.U.
LUT
S-IVB
S-II
S-IC
I.U.
I.U.
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military—particularly with respect to solution of programming difficulties. They will listen, they say, to "anyone who has been through the mill on automated checkout."

For example, much has been learned from the VATE (Versatile Automatic Test Equipment) program carried out by Hughes Aircraft Co. in the area of automated guidance and control checkout. Also, *Polaris* programming and checkout, among other military programs, has had an impact on *Saturn* philosophy. "The concepts translate well even if the black boxes don't," says Jack Underwood, Assistant Director for Checkout in NASA's Manned Space Flight Office.

- **Guide to future**—The *Saturn-Apollo* program embodies most if not all of the new concepts which should govern NASA mannned spaceflight efforts for the foreseeable future beyond *Gemini*.

These include:

—Use to the greatest possible extent of flexible and fully automated digital computer-controlled checkout (as opposed to semiautomatic sequencer-type equipment) to handle the vast amounts of data required.

—Flight-readiness-type checkouts at the factory level—tests employing the same equipment, operating with the same programs, and in some cases run by the same persons who will make the final flight tests at the Merritt Island Launch Area (MILA).

—Delivery of assembled flight-ready vehicles to the launch pad, guaranteeing a minimum of pad checkout and minimum time on the pad.

- **Opportunities**—For t/c equipment manufacturers, the U.S. manned lunar program represents a lucrative but tricky market.

NASA officials say no real equipment breakthroughs or major advances are needed to handle *Saturn-Apollo* test and checkout, though improvements in data compilers and some peripheral mechanical and hydraulic devices, transducer flow meters, and leak detectors would be welcome.

Extensive use of digital computers in correction test and checkout programs is likely to expand production of the more accurate sensor-amplifier equipment used in making test measurements. And there is a big market for RFI-proof components.

There is, however, an immensely sticky information problem, peculiar to this program, which will not be handled by off-the-shelf automated checkout systems. It is usually a waste of a manufacturer's time, says NASA, to try to sell an automatic or semiautomatic system that was developed for another program.

Basically, the *Saturn* checkout will be developed around various flexible general-purpose digital computers. Interestingly enough, NASA reports, some computer firms that also have checkout capability and experience are bidding on certain portions of *Apollo* checkout but are including another firm's computer regarded as superior for NASA's purposes.

NASA points out that the exact level of fault isolation on *Advanced Saturn V* is not yet determined, and will of course depend to some extent on the experience built up and the needs outlined in the earlier *Saturn* programs.

Marshall Space Flight Center, whose basic documents in *Saturn-Apollo* automation concepts served to pull together all the elements leading up to automated test and checkout, originally intended to limit diagnostic procedures at the launch site to black-box or subsystem level, if automatic fault isolation is considered in the design of these boxes.

The MSFC computer-controlled system reportedly has all the inherent characteristics required to isolate faults to black-box level or even lower; however, flight hardware and vehicle design must include the means to monitor all critical points, and the computer program must utilize these points efficiently.

- **Man-machine**—NASA officials feel that man-machine interface is probably their most difficult problem. They see the *Saturn-Apollo* program as falling somewhere between the R&D-type program—where highly complex equipment is operated by scientists, and the ICBM-type program—where somewhat less complex gear is at the same time less understood by its operating technicians. This, they say, is philosophically akin to any automation problem and requires much more emphasis from an industrial engineering approach. Another problem, perhaps equally severe, is that of effective computer programming. But this is at least a recognized problem.

- **Launch complex**—The Merritt Island Launch Area and its Integrated Launch Control and Checkout System (ILCCS) form the heart of the *Saturn-Apollo* test and checkout complex.

MILA is designed with an emphasis on mobility, so that actual pad time will be held to a minimum. This involves: initial test, checkout, and assembly of *Saturn* stages on a mobile launcher-umbilical tower (LUT) in the huge vertical assembly building (VAB); moving the LUT by a crawler-transporter to the launch pad, with all connections between the space vehicle and the LUT intact; and final pre-launch checks and launch operations from the launch control center (LCC), 3 miles distant, via a new digital data acquisition system (DDAS).

- **Digital link**—The DDAS to be used in *Saturn* is important in that it reflects a growing trend among spacecraft designers to use the vehicle's telemetry system, operating over an RF link, as a source of data for pre-launch monitoring and checkout. The extent of its use in *Saturn* is not yet completely firm, but it is expected to be widely used in the spacecraft, instrument unit, and upper-stage portions of the overall vehicle. It probably will be used to a lesser extent in the S-IC stage, where more traditional hardwire umbilical connections are likely.

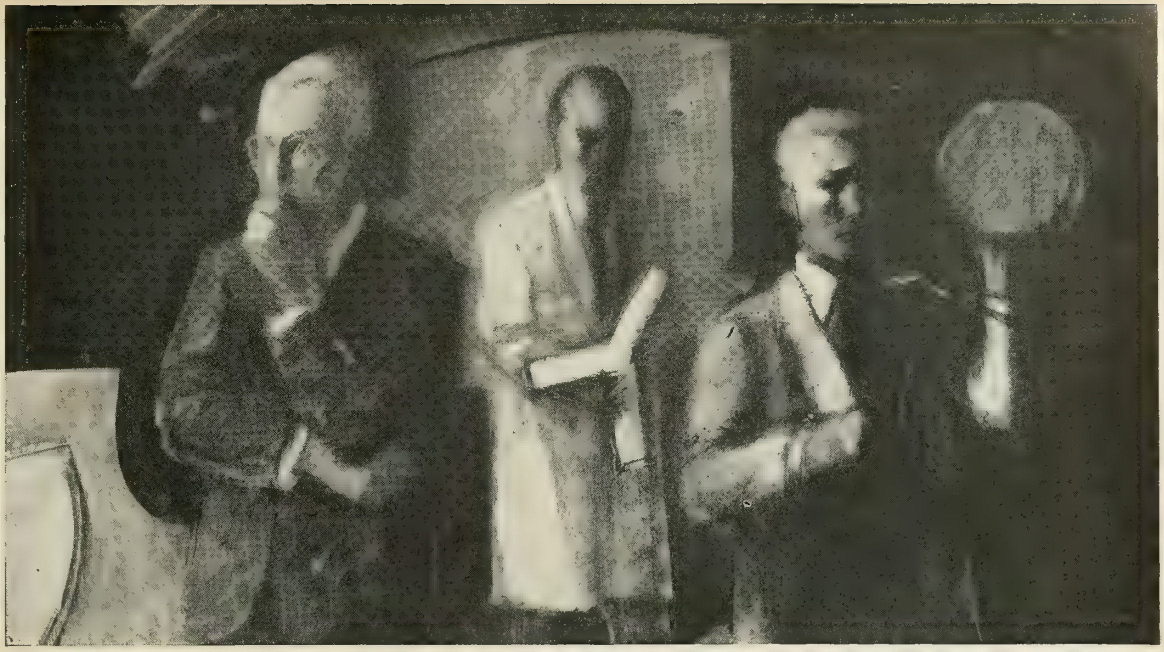
Such a link raises problems, particularly in RF time and interference. But the advantages, as enumerated by MSFC, are impressive: number of wired connections between vehicle and launch pad is reduced; problems from electrical ground loops, noise pick-up, cable losses, and other anomalies inherent in hardwire analog transmission are reduced; data are changed into digital form as near the source as possible; digital t/m techniques provide more reliable, error-free transmission; with addition of ground equipment, data can be presented to more than one computer at a time; checkout with minimum change in vehicle design is possible; distance no longer becomes a basic limitation; monitoring may be continued after lift-off with no system change.

Perhaps its most far-reaching advantage is the link's compatibility with orbital operations and operational flight control, which can supply a ground-based computer complex with data for real-time decisions. With the addition of a digital command link, the DDAS could extend the degree of orbital checkout and also provide astronauts with visual stage-monitoring data.

Apt to hasten this concept even further is the growing NASA interest and apparent success in development of digital telemetry transducers. NASA reports it is "getting real good results" in the development of force-, acceleration-, and pressure-type transducers which were traditionally straight analog devices.

This same concept could be applied to the *Nova*-type booster, which probably will be erected right on the launch pad, since it would be too large for a transporter device, with a computer and launch vehicle checkout facility located even further away from the site than with *Saturn*.

- **Check sequence**—Essentially, the first-stage and spacecraft checks made at MILA will duplicate factory checks and will proceed in a building-block fashion. Though final stage checks at factory level are to be fully automated, many of the subsystem tests, such as guidance, may be performed initially with semiautomatic and perhaps manual



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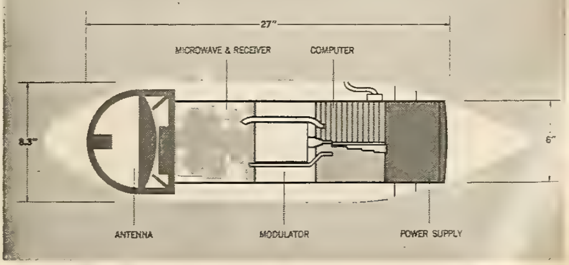

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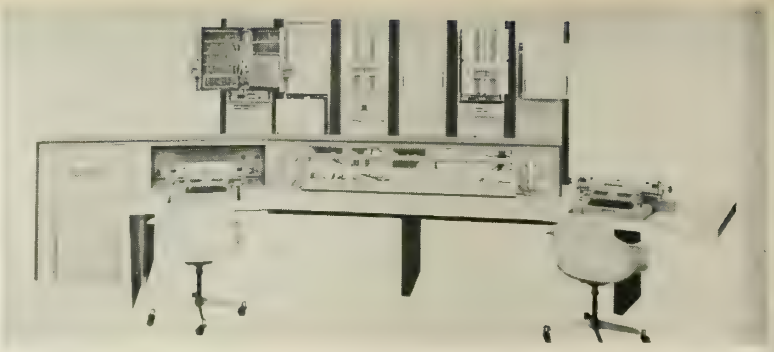
procedures, leading up to fully automatic systems verification at MILA as part of the stage or module.

NASA says the first stage (Boeing's S-IC will require about eight weeks to check out on the LUT in the VAB. The second and third stages (NAA's S-II, and Douglas' S-1VB) will each require about four weeks in the lower bay areas of the VAB before they are mated to the S-IC.

The major difference between launch pad operations and stage checkout lies in the proportions of measuring stimulation and calibration operations. At stage areas, there is a much larger portion relating to proving instrumentation systems.



RECENTLY formally accepted by Marshall Space Flight Center was this Saturn Automated Checkout Equipment designed, built and installed by Packard Bell Electronics.

The *Saturn* test and checkout as a vehicle begins with the mating of the S-IC first stage to the launcher-umbilical tower in the VAB. The stage will be vertically aligned, mated to the GSE, and connected to necessary simulators. The LUT electrical GSE will actually be connected to the LCC via the high-speed data link, allowing the S-IC test program to be carried out with actual launch equipment and personnel.

After these checks, the *Saturn* Instrument Unit (IU), and S-II and S-IVB stage simulators will be electrically coupled to the S-IC for interface checks and a final checkout of the vehicle.

The computer complex used to check out this first stage will later double as the Launch Vehicle Checkout System, operating as a master sequencer, in conjunction with the *Apollo* spacecraft checkout computer, to perform the entire *Saturn V-Apollo* pre-launch tests.

- **System flexible**—The launch vehicle checkout system's ability to operate independently if required gives the system added flexibility for adaptation to payloads other than *Apollo.*

The checks for the S-II and S-IVB stages are essentially the same as for the S-IC, with the same equipment used in the VAB lower bay test cells as is used at the factory and static test stand. The computers which carry out these checks, however, will not be used again in the MILA test sequence. Following mating of these stages and the IU with the S-IC stage, the launch vehicle checkout system will take over for all subsequent tests.

NASA says portions of the automated test equipment at the Michoud, La., plant where the S-IC stage is to be built will be government-furnished. The systems for the S-II and S-IVB stages are being procured by the stage manufacturers with inputs by Marshall Space Flight Center (MSFC). Control Data Corp.'s 924 computers have been selected for these two stages.

NASA's early efforts to automate the *Saturn V-Apollo* launching are beginning with the earlier programs. For example, Packard-Bell computers to be used on the first stage (S-I) of *Saturn I* are being used to develop an approach to factory checkout early in the program. Also, MSFC systems to check out instrument units and complete launch vehicles for *Saturn I* and *IB* are being designed around RCA-110 computers, with the distinct possibility that the *Advanced Saturn* S-IC stage and launch vehicle checkout system may be based on the 110.

Complex 37 at Cape Canaveral will be the first *Saturn* site equipped for fully automatic launch operations. Complex 34 will later be retro-fitted for this same capability. The *Saturn IB* will actually be the first class of *Saturn* vehicles to go through fully automated test and checkout procedures at factory and launch areas.

The *Saturn I* S-1 stage will go through automated checkout with the Packard-Bell units at Michoud. However, there is no automated test program for the second-stage (S-IV) of the *Saturn I.* When the two stages and the IU are mated, an automatic checkout using the launch vehicle checkout system designed around the RCA-110 computer will be performed.

With the IB, Douglas will introduce automated stage checkout at its plant, using the CDC device, and will then lend fully automatic status to the program.

In *Saturn V*, after the S-II and IVB stages are electrically mated to the LUT-GSE, a series of limited stage checks is performed prior to complete electrical mating of all stages and the IU. Launch vehicle systems tests made at this point cover control, ordnance, and RF systems. An overall vehicle checkout follows.

One of the big payoffs that NASA points to in the press to automate effectively was the fact that MSFC, while leading in the development of the broad automation plan for *Saturn-Apollo,* was also charged with development of the IU package. The physical location of the test points in the IU is the key which influences test sequence and accessibility. The IU, considered as a stage by MSFC, is checked out as a system using similar stage checkout methods. The concept that could evolve for testing the IU—which contains the guidance, telemetry, instrumentation, and measuring devices—in quantity includes five so-called satellite stations capable of either automatic or manual operation with the test program controlled by a 110-type computer.

NASA reports that component and systems test of the *Apollo* spacecraft will be performed in the Operations and Checkout Building at MILA. Static tests performed here are the only ones made on the flight modules after manufacture and before launch. The *Apollo* command and service modules will be assembled and verified as a combined unit. The LEM will get individual module attention, in addition to later checks of the complete spacecraft.

The equipment which will perform the *Apollo* spacecraft checkout bears the acronym PACE-S/C—for Pre-Flight Acceptance Checkout Equipment for Spacecraft. Prime contractor on supply and implementation of PACE-S/C, in addition to the entire launch vehicle checkout system and certain Launch Operations Center displays, is General Electric Co. GE will actually build some of the equipment, much will be bought, and some will be government-furnished equipment.

The PACE equipment at MILA will be identical to that furnished by the government to Grumman and North American for facilities checkout. The equipment will also serve a third purpose later in the program, as it joins with the launch vehicle checkout system, certain additional facilities checkout, and common displays at the launch control center to form the ILCCS. The two computers will be physically remote from each other and separately programmed, with the launch vehicle device acting as a master sequencer.

(Continued on page 52)

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(Continued from page 50)

Centaur To Be Most Thoroughly Tested

THE GROUND TESTING program for *Centaur* has been increased 800% over initial estimates.

This new and very heavy testing program, according to a NASA official, results from some early development troubles, and the failure of the first flight. NASA grew to realize, the official says, "that this (ground-testing) was not just a technical exercise but a full-grown, complicated problem." The space agency has announced that *Centaur* will be the most thoroughly tested space vehicle to date.

● **Goals**—Checkout philosophy, says Grant L. Hansen, General Dynamics/Astronautics vice-president and *Centaur* program director for GD/A as prime contractor, "is to aim our efforts at reducing on-stand time at Cape Canaveral to a minimum. The goal is to have the vehicle thoroughly checked out and nearly flight ready when it is placed on the stand."

In particular, the cryogenics associated with the liquid hydrogen fueled *Centaur* demands rapid launch pad checkout and minimum pad time. This same factor will influence requirements in portions of the *Saturn* program and with nuclear stages when they became operational.

Indicative of *Centaur* test program intensity is a new flight-simulating facility being designed to check out an entire *Atlas-Centaur* in combination with the *Surveyor* spacecraft.

Construction of the new facility, called a Combined Systems Test Stand (CSTS), is to begin during the third quarter of this year on a 3½-acre site adjacent to GD/A in San Diego. Costing an estimated $6.8 million, the CSTS will include structures with 22,000 sq. ft. of floor space, plus test equipment. The CSTS, which NASA says will be operational late next year, is scheduled to support *Centaur/Surveyor* development missions in 1964 and lunar flights beginning in 1965.

GD/A claims the CSTS will be the first known facility designed specifically to accommodate all stages of a space vehicle for unified ground testing at the "factory" level. NASA points out that the much smaller *Scout* vehicle does this to an extent, but that there is no comparable manufacturer's checkout for *Atlas-Agena, Thor-Agena,* or *Thor-Delta.* In the facility, the *Atlas* launch vehicle will be horizontal. *Centaur,* with *Surveyor* mounted on top, will stand vertically near *Atlas.* All three stages will be mated electrically and will function as if actually united.

● **Realism**—The current process, NASA reports, is to check out the *Atlas* and *Centaur* separately, mate them, then perform a systems test at the launch site.

During tests, the vehicle systems will be exercised through most flight operations, except actual engine ignition, just as they will during actual prelaunch countdown and flight.

"As far as the vehicles are concerned, they will be operating on an actual flight to the Moon," Hansen said. "Guidance will maintain course, autopilot will direct required flight sequences, telemetry will broadcast vehicle performance data, and engines of both *Atlas* and *Centaur* will actually gimbal as if maintaining attitude and course control."

He said CSTS will provide insurance that systems of all stages are compatible and functioning together as required before shipment to Cape Canaveral. Delivery of totally tested, flight-ready vehicles to AMR will reduce preflight test time at the launch complex, and insure that the vehicle is ready for flight at the required time, Hansen said. GD/A will operate the test facility for NASA.

The test crew will include personnel from NASA, General Dynamics, Hughes and Jet Propulsion Laboratory—the latter two being responsible for *Surveyor.* Members of the flight team from the Cape also will participate in the testing to familiarize themselves with the vehicle before launching.

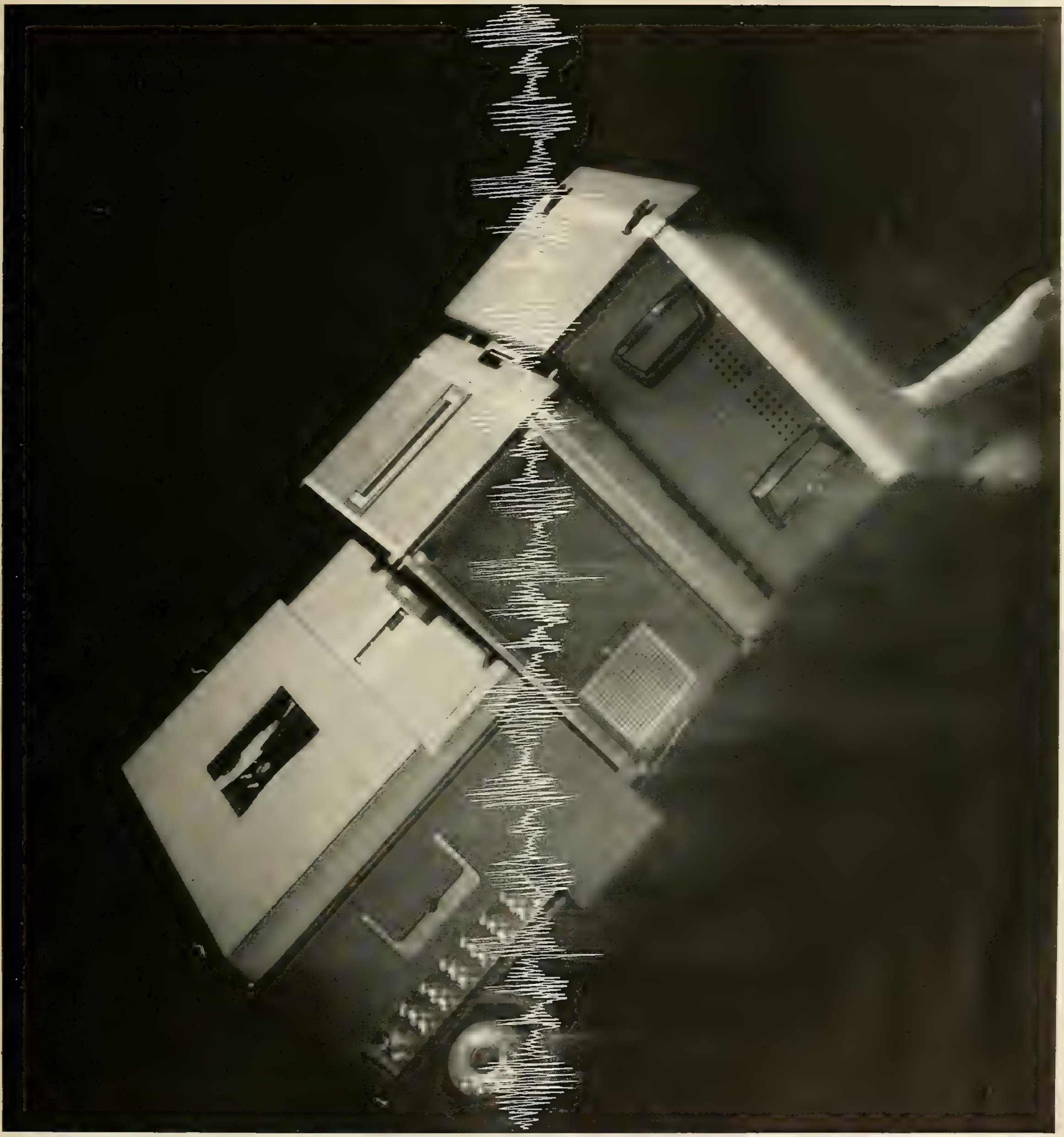
Test personnel will conduct flight simulations from a control center nearly identical in appearance and equipment to the blockhouse at the Cape. Ground support equipment used in CSTS will closely duplicate counterpart equipment at the actual launch complex. On operational models, NASA states that the launch site systems tests will be in slightly less detail than those made at GD/A.

Present plans call for all *Centaur* launches to be made from the Cape. R&D missions are flown from complex 36-A, used for the first *Centaur* flight in May, 1962.

A second launch complex, designated 36-B, is under construction. Both will share a common blockhouse, with two sets of ground support equipment. providing separate instrumentation for the two pads. Pad 36-B is not expected to be available for development flights. NASA has announced that when the second complex is completed, *Centaur* will have a mission capability of one per month. GD/A also has responsibility for GSE associated with 36-B.

● **Engineer control**—GD/A reports

(Continued on page 78)



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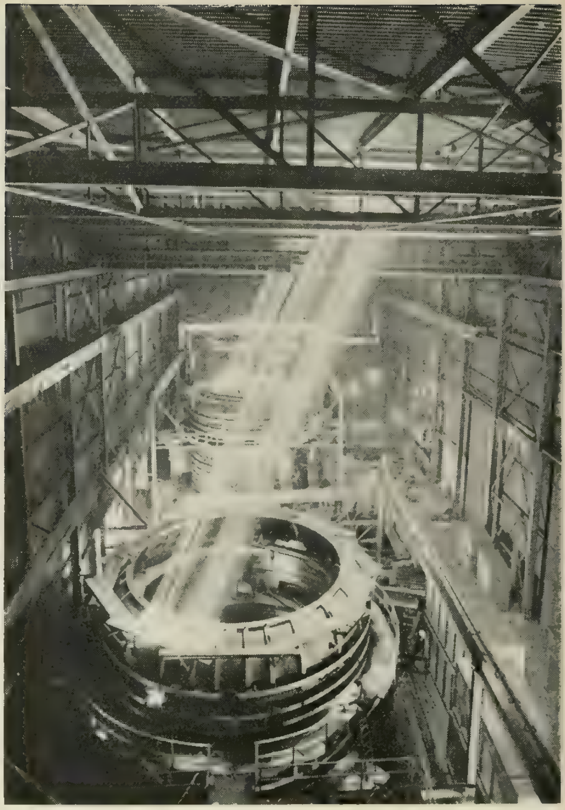
Test Chamber Art Suffers From Lack Of Information

Critical parameters remain undefined, calibration standards to be developed, exotic conditions can't be simulated



TWO HUGE chambers being built for Goddard Space Flight Center will be used to test large spacecraft. They're 33 ft. in diameter, 58 ft. high.

DESIGN AND CONSTRUCTION of space chambers is the major activity in the field of environmental testing, but in common with other areas in the field, it is still in its formative stages.

Methods and degrees of simulation have not been fully established. Information is lacking on critical parameters. Improvements must be made in measuring instrumentation and techniques. Calibration standards still must be developed.

These shortcomings are spelled out in research studies recently conducted by ARO, Inc., for the Air Force's Arnold Engineering Development Center at Tullahoma, Tenn. The studies were undertaken in support of the development, design and operation of AEDC facilities such as the J-2A rocket test cell (now in operation), the Mark I environmental chamber (under construction), and other facilities in planning stages.

The AEDC report covered only the more obvious problems of space simulation, such as vacuum technology, solar radiation and instrumentation. It pointed out that it would be desirable to simulate in space chambers other, more exotic, parameters—relative vehicle motion, zero gravity, Van Allen belt and cosmic radiation, micrometeoritic particles, and magnetic fields. But it said that a great deal of research is still required before these factors are fully understood and feasible methods can be developed for their simulation.

- **Design problem**—A space chamber is a collection of subsystems: shell (or vessel), vacuum system, thermal system, solar simulators, and various test equipment, controls and instrumentation. Each of these component parts plays an interacting role, and the overall system design demands a high degree of integration.

Nothing about the space chamber is simple. Duplicating a relatively small sample of outer space on Earth generates unique problems. The enclosing shell structure, for example, is basically nothing more than a simple steel cylinder or sphere. But when it is used to contain the high vaccum of simulated space, numerous exotic considerations enter into selection of material and construction methods.

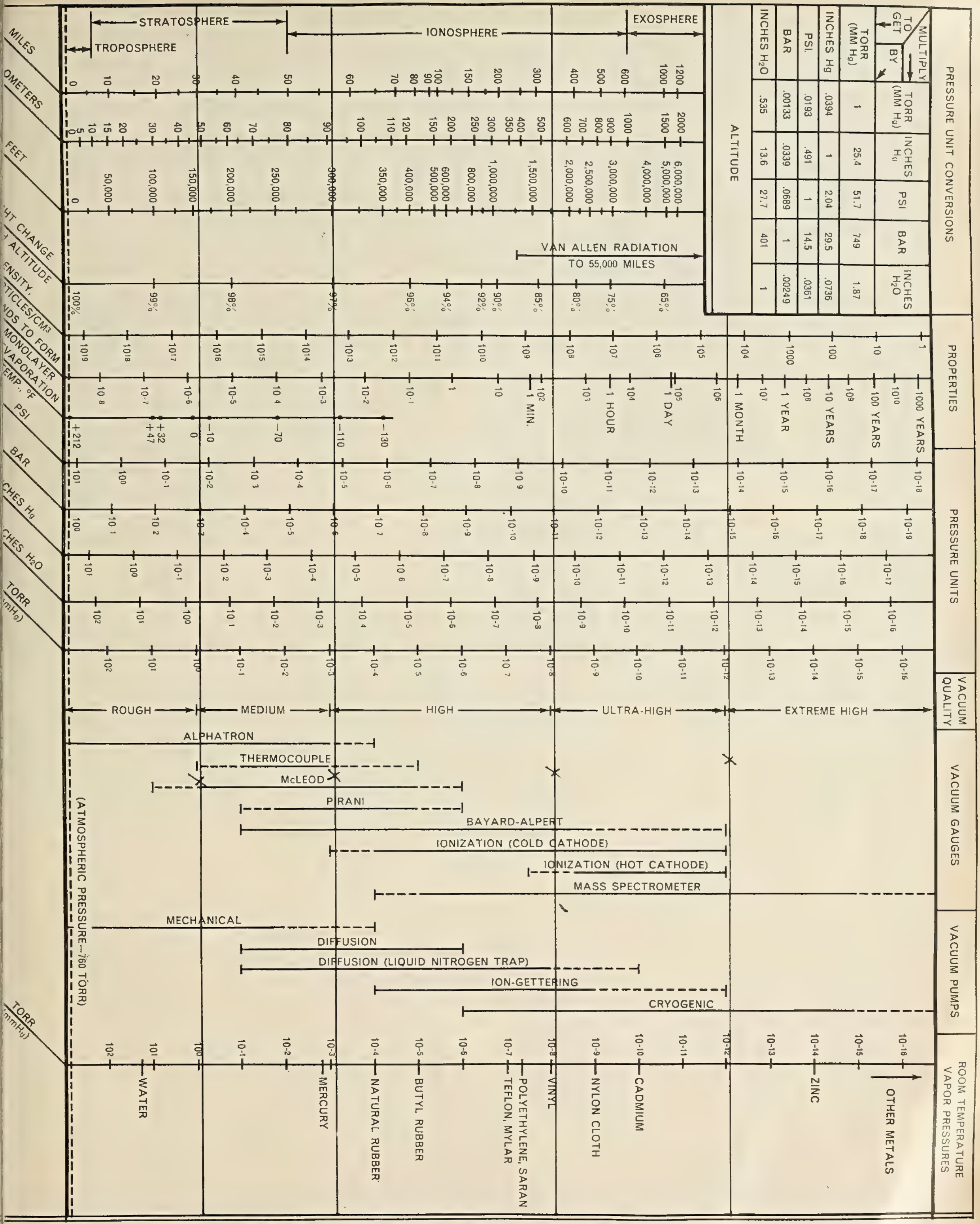
Outgassing, for instance, is an important consideration for which few data are available. Welding poses special problems. In one case, engineers constructing the NASA Goddard Space Flight Center found that full-penetration, multipass welds—radiographed on completion to insure absence of porosity in the weld—should be used exclusively in the shell fabrication.

Stainless steel is used in practically all large chamber shells for its lower outgassing and smooth surface. But engineers at NASA's Langley Research Center are using plain carbon steel—at a two-thirds saving over stainless, they say—in the construction of the new chamber there. The interior of the chamber will be coated with a plastic "paint" to seal and smooth the surface and protect against rust.

Whether this new technique will prove entirely successful won't be known for certain until the chamber is completed and checked out this month.

- **Adding size**—The present state of the art is typified by the large space chambers at NASA's Goddard Space Flight Center, General Electric's Missiles and Space Division, and Jet Propulsion Laboratory. An extension in size is represented by the 120-ft. chamber planned for NASA's Manned Spacecraft Center in Houston.

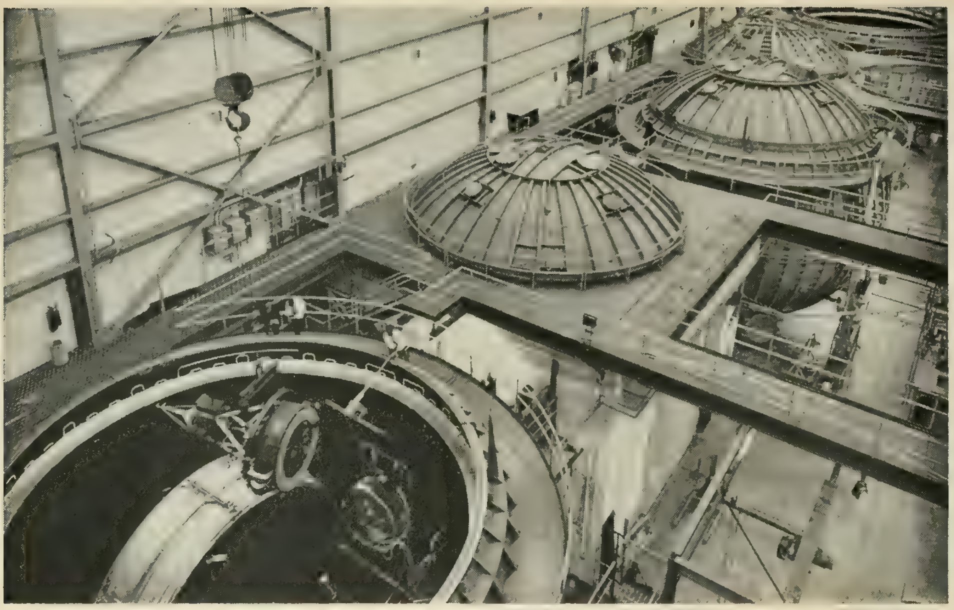
Although some experts feel that



TO GET ↓ / MULTIPLY BY →	TORR (MM Hg)	INCHES Hg	PSI	BAR	INCHES H2O
TORR (MM Hg)	1	25.4	51.7	749	1.87
INCHES Hg	.0394	1	2.04	29.5	.0736
PSI	.0193	.491	1	14.5	.0361
BAR	.00133	.0339	.0689	1	.00249
INCHES H2O	.535	13.6	27.7	401	1

SPACE SIMULATION CHAMBER VACUUM MEASUREMENT UNITS, PROPERTIES AND OPERATING PARAMETERS OF TECHNIQUES AND EQUIPMENT

Chart courtesy Douglas Missile & Space Systems Division.



TEST MODEL of Nimbus spacecraft is lowered into 38.5-ft. chamber at GE's Valley Forge, Pa., facility.

even larger facilities will be needed, no serious consideration has been given to anything larger than a 200-ft. sphere. At any rate, construction of larger chambers would for the most part require engineering refinements rather than significant advances in technology.

The principal engineering problems involved, say J. C. Simons, Jr., and M. P. Hnilicka, of National Research Corp., are optimizing chamber structure, minimizing gas load, and achieving adequate vacuum pumping speed, better seals and leak-detection methods, and adequate cryogenic heat-sink simulation.

- **Nuclear puzzlers**—A new area which poses its own problems is the environmental testing of nuclear spacecraft. Facilities, structural design, instrumentation and controls are all subject to the effects of nuclear radiation. Design criteria for a nuclear-cryogenic system must provide maximum simulation with minimum risk of radiation damage or personnel hazard. The special considerations include:

1. Handling of radioactive elements.
2. Contamination of the nuclear system in case of accident.
3. Functional degradation of materials and components.
4. Decontamination.
5. Personnel protection.
6. Radioactive waste disposal.

Nuclear payloads are subjected to a number of environmental stresses that must be simulated as nearly as possible. Prelaunch checkout of the reactor subjects the system to extreme temperature cycles. During launch, there are peculiar effects such as "vacuum shock," the rapid reduction of ambient pressure from one atmosphere to space vacuum in a very short time span. This can produce structural damage that may not be produced by slow pump-down in a typical vacuum chamber.

Once in orbit, the payload is subjected to the heat transfer cycle caused by solar radiation and space heat transfer. During this period the vacuum drying effect is pronounced. Then, when the reactors are started up, a high-temperature shock is produced on the entire system; relative expansion and control problems are severe. During the space life of the vehicle these high temperatures combined with hard vacuum and nuclear radiation produce long-term destructive effects. These problems are difficult to investigate by environmental testing.

- **Materials testing**—There are strong differences of opinion about the best way to qualify materials for very hard vacuums—that is, vacuums greater than 10^{-10} torr. One school holds that it is sufficient to check out the materials in a "bell-jar" type facility; another feels that a total systems evaluation is needed.

Oddly enough, very few test engineers advise a compromise. On the one hand, the bell-jar is said to be sufficient to tell everything that will happen to a material; on the other, there is doubt that the problems of interfacings—such as cold welding, sublimation and lubrication—can be solved without total systems evaluation.

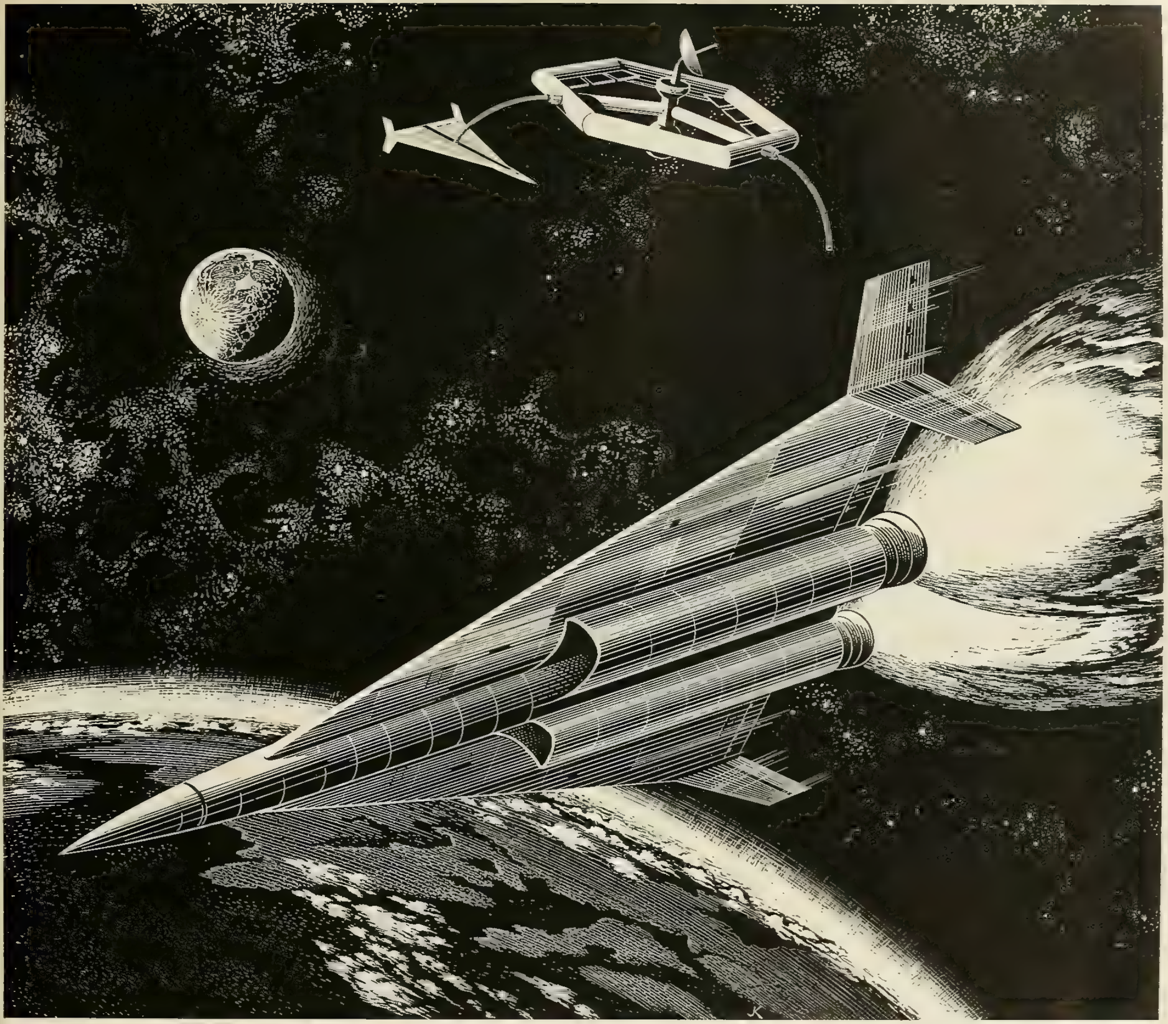
The joker is that there is as yet no chamber able to take a complete space system down to a hard vacuum. This is not to say that "empty" chambers can't be taken this low. But under working conditions, a large chamber can reach 10^{-8} torr at best.

Lack of hard-vacuum testing may conceivably have doomed the October, 1961, West Ford experiment, in which the Air Force attempted to orbit 50 lbs. of fine copper wires at an altitude of 2,000 miles (M/R, May 13, p. 13). A scientist connected with the experiment pointed out that benzene was used as the adhesive to hold the 10^{-6} mm-dia. needles together. It was thought that in space, the benzene would sublimate, and the needles would become separate entities in packages ready for injection. In a test vacuum of about 10^{-7} torr, the surmise was correct. But later, after the Air Force failed to put the needles into orbit, a second test presumably at a pressure greater than 10^{-10} torr revealed that the copper wires became cold-welded to one another.

- **High vacuum**—Most modern large space chambers are capable of working pressures of 10^{-5} to 10^{-8} torr—the equivalent of 100-300 miles altitude. Pressures of 10^{-12} torr (1500 mi.) are within the state of the art. A small chamber capable of 10^{-15} torr has been successfully developed by National Research Corp., which says it can be sealed up to a chamber of several thousand cubic feet.

Exotic techniques and equipment are necessary to obtain and maintain such high vacuums, however, and instrumentation beyond the 10^{-10} range is practically beyond the state of the art.

Considerations in the design of the vacuum system include leakage, outgassing, and gas load from the spacecraft (or other equipment in the chamber). All of these are, of course, taken into consideration in the design of the



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Propulsion for the Aerospaceplane concept is one of a number of major contributions to advanced technology by engineers and scientists at Marquardt. This revolutionary system requires a propulsion system capable of take-off from conventional runways, acceleration through the atmosphere, orbital cruise in space, and return for an earth landing.

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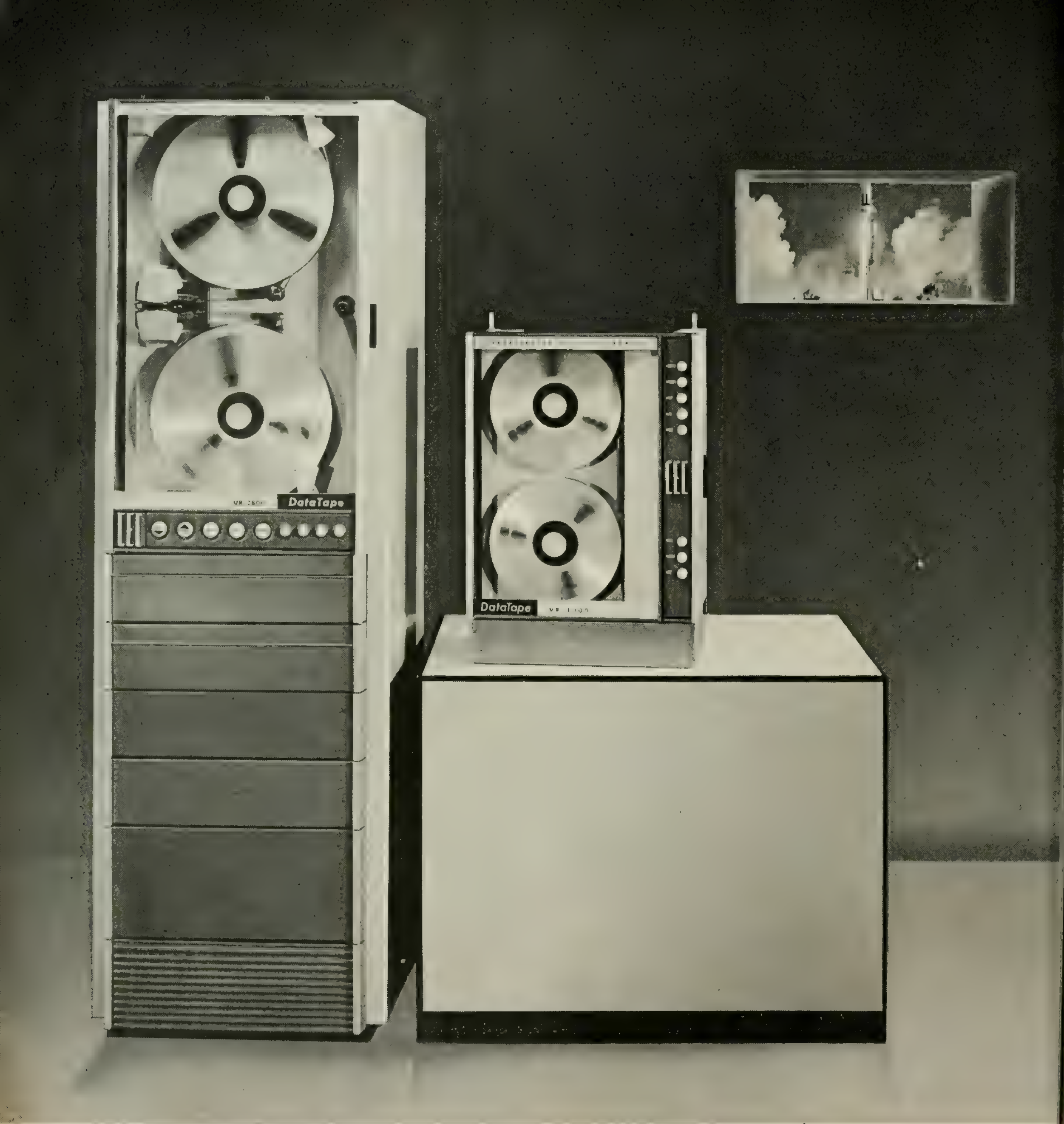

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vacuum pumping equipment.

Before the 50,000-cu.-ft. chamber at NASA-Goddard was designed, a survey was made to determine what types of pumping equipment were available and suitable. The study considered the mechanical pump, diffusion pumps, ion and ion-getter pump, and cryo pumps. The final system, like most others in use, combines the advantages of several different types to provide the most effective and economical pumping possible.

LOCATION	*SIZE* *(ft.)*	*VACUUM* *(torr)*
Jet Propulsion Labs	27 x 53	1 x 10^{-6}
General Electric	38½ x 30 (3)	1 x 10^{-8}
NASA Goddard	35 x 60 (2)	1 x 10^{-8}
NASA	65 x 120	1 x 10^{-5}
Houston	35 x 43	1 x 10^{-4}
NASA Langley	55 x 58	1 x 10^{-4}
Douglas	39 (spherical)	1 x 10^{-10}
Republic	13 x 24	1 x 10^{-8}
North American	15 x 28	1 x 10^{-8}
McDonnell	18 x 30	1 x 10^{-8}
Grumman	19 x 26	1 x 10^{-9}
Space Technology Labs.	30 (spherical)	1 x 10^{-7}
RCA	20 x 26	5 x 10^{-6}

SPACE CHAMBER facilities already built or in hardware planning stage indicate impressive environmental test capability in U. S. missile/space program. The list above, while not complete, represents a majority of the newer and larger chambers in this country.

Mechanical pumps are most used as initial "roughing" pumps. At the higher pressures—up to about 10^{-2} torr—they are fast and efficient.

The vapor diffusion pump is basically the standard for the bulk of the vacuum pumping operation. Addition of cryogenic baffle traps extends their effective range up into the 10^{-8} scale. The Goddard survey reports, however, that it might be well to consider the use of vapor boosters to back up the diffusion pump, thus yielding increased pumping speed between the range covered by the mechanical and diffusion pumps. Use of the vapor booster has another advantage, the report says, in that it acts as a baffle to stop contamination of the diffusion pump fluid.

On the basis of their study, Goddard engineers decided that diffusion pumps suitably baffled against backstreaming would provide the most flexible system and allow the addition of more pumps at a later date. Their report stated that the diffusion pump, "even considering its undesirable characteristics," seems to be the leading contender for a pumping mechanism for large space chambers. They said the results of their feasibility study made it "even more evident" that the diffusion system is the most flexible and economical means of pumping.

Goddard's 35 x 50 ft. chamber can be pumped down to 10^{-5} torr in seven hours, and down to 5 x 10^{-8} torr in 48 hours, using 17 50,000 liter/sec. diffusion pumps.

Ten 35-in. diffusion pumps, each with a capacity of 52,000 liters per second, are used in the 47 x 25 chamber at JPL. This three-stage system can evacuate the chamber down to 10^{-8} torr in 3½ hours.

Contamination is the big problem with the oil-diffusion pump. "Backstreaming," or the migration of oil particles into the vacuum environment, is an inherent feature of such a system. Different types of baffles, connected with the pump, have been developed to eliminate this problem to a large degree, if not entirely. National Research Corp., for instance, produces several types for different applications; these include a molecular sorbent baffle, a water-cooled unit, and one cooled by liquid nitrogen for ultra-high-vacuum construction.

Ion and ion-getter pumps offer several advantages over the diffusion pump. Recent refinements have eliminated some of their earlier disadvantages and reduced others.

The major advantage of the ion pump is the complete absence of contamination in the vacuum chamber. Operating costs are negligible, and practically no maintenance is required.

On the other side of the ledger is the relatively high initial cost of the ion pump installation per unit of pumping speed achieved. Effects of the magnetic fields associated with the pump must also often be considered. The relatively poor performance of the ion pump in handling the noble gases was a problem until recently, but it has been improved upon by the addition of other elements in the pump.

According to Varian Associates—manufacturer of the Vac-Ion pump and licenser to most, if not all, competitors in the ion pump field—cost factors between ion and diffusion meet on even ground at about the 10^{-10} torr range. Here, they say, competition is very close: the 8 or 9 scale, oil-diffusion is definitely cheaper; at 10^{-11} and higher vacuums, diffusion cannot compete with the ion pump.

Actually, the ion "pump" is not a pump at all. It is a gas trap which establishes a low molecular density in itself by permanently trapping gas atoms and molecules in deposits of a reactive metal. These deposits are produced by cathode sputter (the removal of material by positive ion bombardments).

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Dr. Lewis Hall of Altek Corp., believes recent advancements show that moderate-size ion pumps can handle hundreds of thousands of liters per second, making them applicable to chambers much larger than those in which they are now used.

• **Cryomethods**—Cryogenic pumping—or "cryopumping"—performs a dual purpose in a vacuum chamber. Gases at cryogenic temperatures are circulated around the inside chamber surface to provide a cold, black heat sink simulating outer space. In addition, the cryogenic surfaces provide a trap for the gas molecules, serving as a "pump" which can provide equivalent capacities of thousands of liters per second per square foot of surface.

Cryotechniques will play an increasingly dominant role in the pumping of large space simulators. Advanced techniques, such as cryogettering and cryosorption at liquid nitrogen temperatures, offer certain advantages and may also prove more economical.

Cryocondensation, which can handle all the gases except hydrogen, helium, and neon, is at present most attractive technologically and economically. It must be supplemented by other methods, however, to pump the gases mentioned. Cryoadsorption (using sorbents such as molecular sieves, charcoal, and alumina at liquid-nitrogen temperatures) is also limited to the pumping of gases other than hydrogen, helium, and neon. The practicality of this technique has not yet been proven, but there is some feeling that it may be used considerably in the future. Experiments with hydrogen gettering also show promise, and pumping speeds are reported to be encouragingly high.

Cryotrapping—the removal of noncondensable gases by trapping the molecules in a condensing matrix of another gas—also is being considered. Current results, however, do not indicate great promise.

Cryopumping is a complex science—and still in its infancy, but the consensus is that it is the only available technique to answer the future need for the extreme high vacuums (10^{-12} torr and up).

• **Instrumentation**—A major problem in space chamber operation is the lack of suitably accurate and rugged pressure measuring devices. Several different types of gauges are available in the 10^{-3} to 10^{-9} torr range, but all have their limitations. A basic limitation common to all is the lack of suitable standards for calibration below 10^{-6} torr. This is reported to be about the lowest pressure for which the National Bureau of Standards can certify calibration.

National Research Corp., in its experimental extreme high vacuum (XHV) facility, had to resort to complicated and unusual techniques in order to measure down into the 10^{-15} torr range. By using a "calibrated leak" technique, NRC scientists reported they obtained good results with cross-checking between the Redhead and Bayard-Albert gauges down to 10^{-10} torr. Beyond this point, they were forced to make certain assumptions based on a number of complex considerations. Results indicated, however, that the measurements were relatively accurate. Certainly no one could argue with the results and prove his point. NRC is, in fact, proposing that its XHV chamber and instrumentation be used as a calibration gauge for other high-vacuum facilities.

The AEDC study reports that several available types of residual gas analyzers can detect partial pressures down to the 10^{-12} range. These, however, are expensive and not adapted to space chamber use, where total pressure measurements must be made at many different locations.

In the less exotic ranges, the McLeod compression manometer is an accepted standard for calibrating other gauges at pressures about 10^{-5} torr; beyond this point, however, it is not accurate.

Other types of ionization gauges, such as the Bayard-Albert, are commonly used in the 10^{-5} to 10^{-9} range. These gauges are available in both the glass-entubulated and the "nude" type. The entubulated gauge responds to molecular flux and the nude gauge to molecular density. Both, however, are sensitive to gas composition and have a short life in the presence of certain gases.

As yet, there is no good, practical answer to the problem of obtaining high-vacuum measurement that is accurate, relatively simple and inexpensive. Beyond that mentioned previously, no research toward this end was reported at the recent Institute of Environmental Sciences meeting in Los Angeles. Centainly, adequate instrumentation is a critical need if space chambers are to go much higher in vacuum-simulation capability.

- **Giant in Texas**—Present U.S. environmental test facilities will be dwarfed by the new complex planned for NASA's Manned Spacecraft Center. Construction is to begin shortly, and the plant is scheduled to be partially operational (vacuum only) by September, 1964, and completely operational by February, 1965.

Contracting will be done in four phases, with the first—fabrication of the two test chambers—due to start immediately. Contracts for the building proper probably will be awarded in late June. Equipment systems are now under design and will be ready for contracting along with the building schedule.

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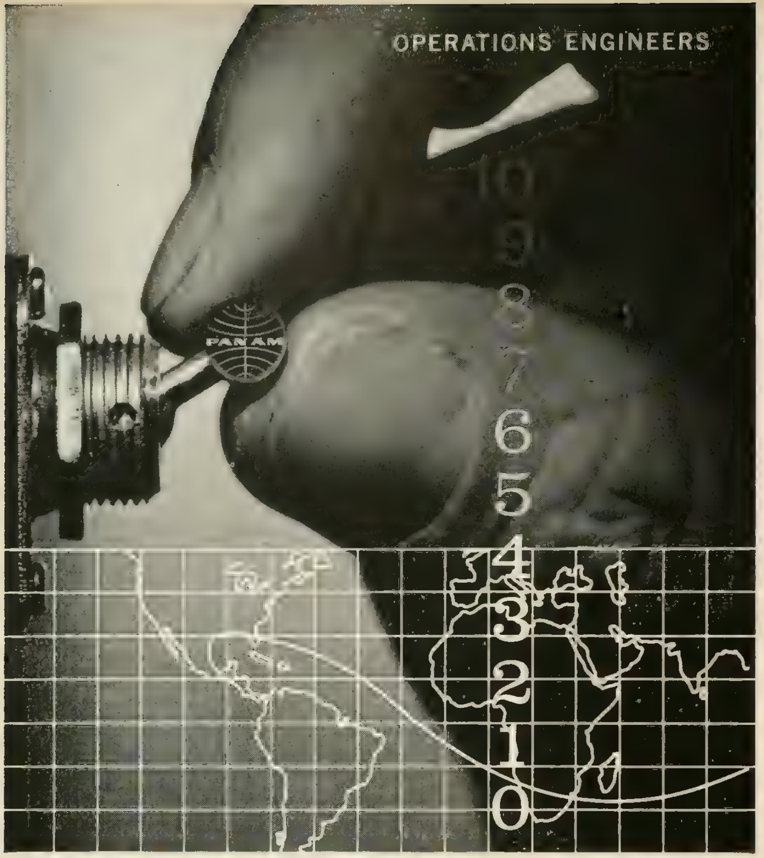

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The last phase—space chamber turntables—will be installed as other portions are completed.

NASA says the new plant will have capabilities not available in existing facilities, from the standpoint of size, performance, man-rating, and work loads.

The Houston complex will contain two space chambers: a space and lunar-surface environment simulation chamber and a smaller chamber for astronaut training. Both will be housed in a single building, and they will share many auxiliary equipments and services.

The larger of the two chambers, providing the vacuum, thermal, and solar-irradiation environment of space and the lunar surface, will be a vertical, cylindrical stainless-steel vessel approximately 65 ft. in diameter and 120 ft. high. It will accommodate full-scale *Apollo* spacecraft and larger vehicles up to 75 ft. high, 25 ft. in diameter, and with a base diameter of 40 ft.

The chamber's vacuum system will use a combination of mechanical, diffusion and 20°K cryopumping sufficient to maintain a pressure of 10^{-6} torr with a gas load corresponding to twice that estimated for an *Apollo* spacecraft and two space-suited crewmen in the chamber. Pump-down from atmospheric to the test condition will require 24 hours or less.

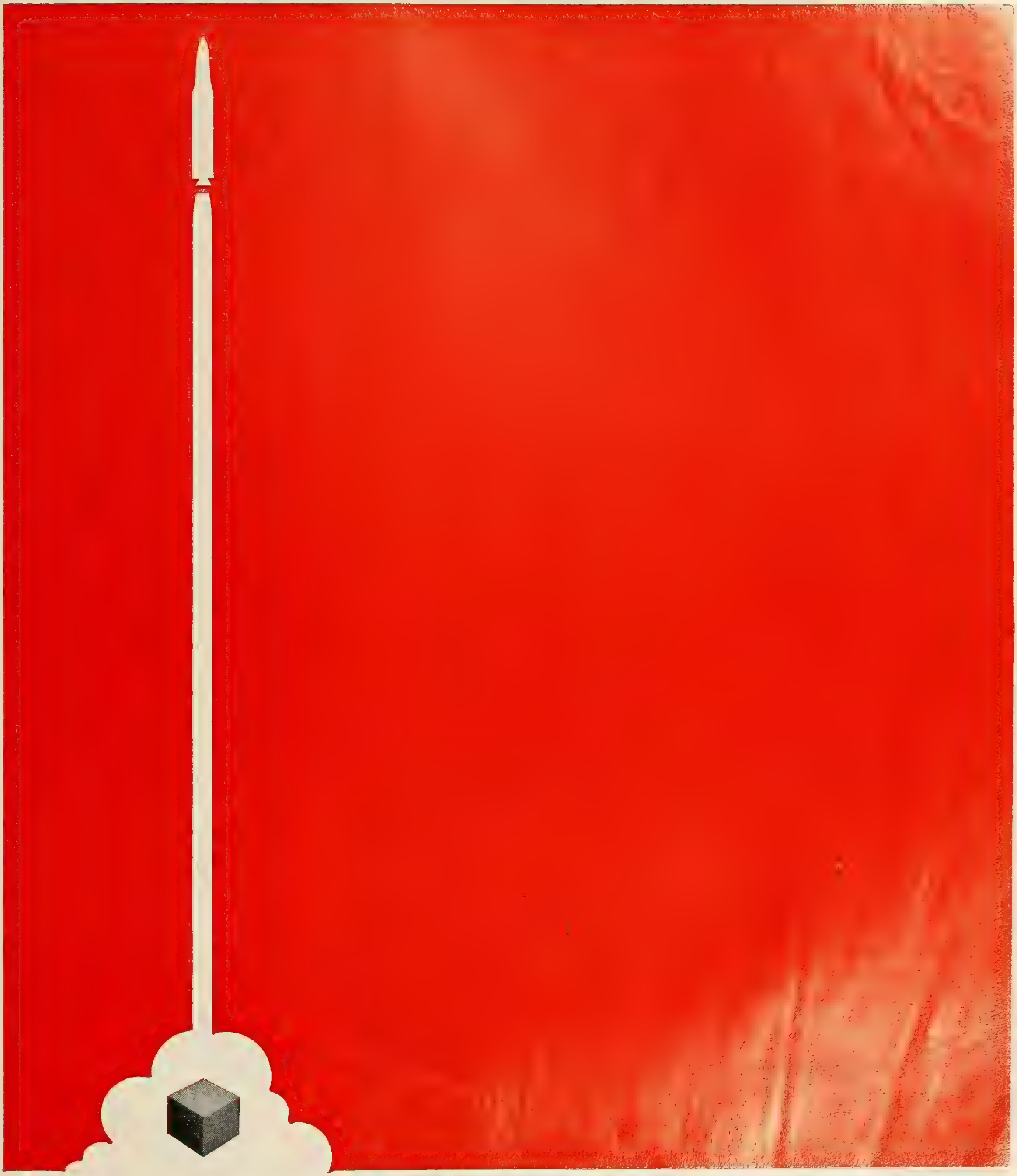
The interior of the chamber will contain a shroud of black, nitrogen-cooled panels at approximately 100°K to simulate the heat-sink characteristics of space.

Modular carbon-arc solar simulators, mounted externally on the chamber's side and top, will irradiate the test article through ports in the chamber wall. These will provide an intensity of up to 140 watts/sq. ft., corresponding to solar radiation intensity at Earth-lunar distances from the Sun. Radiation will be collimated within 1.5 degrees and uniform in intensity within 5%.

The chamber will contain a variable-speed turntable vehicle mount for rotating test vehicles of up to 150,000 lbs. at rates up to 1-2/3 rpm. For space-environment simulation, the turntable will be cooled with liquid nitrogen to 100°K. It will rotate the spacecraft as required to obtain the desired orientation with respect to the solar simulators. For lunar surface simulation, the turntable will be heated to 400°K by electrical heating units.

- **Checking out astronauts**—The smaller space chamber—for astronaut training—will be a vertical stainless steel cylindrical vessel 35 ft. in diameter and 43 ft. high. It will be capable of accommodating the combined *Apollo* command and service modules.

The chamber will be used primarily



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for training astronauts and in developing space suits and other personnel space equipment.

The thermal balance of spacesuited astronauts will be studied on the simulated lunar plane. The chamber is capable of continuous operation for periods of up to 30 days and can provide astronaut training in real-time simulated missions.

The vacuum system for this chamber will contain mechanical and diffusion pumps capable of maintaining a pressure of 10^{-4} torr with a gas load corresponding to twice the leak rate estimated for an *Apollo* command module, a service module, and two spacesuited personnel in the chamber. Pumpdown from atmospheric to test conditions will require about three hours.

Cold-wall heat-sink provision will be the same as for the larger chamber except that cryopump panels will not be used. A turntable mount suitable for a 75,000-lb. test vehicle is included. It will be cooled by liquid nitrogen to 100°K or heated by electrical heating elements to 400°K.

A solar simulator at the top of the chamber will irradiate a horizontal test area of 25 sq. ft. Simulator characteristics and design are the same as those of the larger chamber.

The astronaut chamber will be manrated and have one double man-lock for access. Personnel in the chamber will be observed through closed-circuit TV and by direct observation through ports.

The balance of the Houston test facility will include a flight acceleration facility (with 50-ft. centrifuge); thermochemical test area for testing reaction controls, attitude control systems, space power systems, fluid components, and pyrotechnics; and a structures and material laboratory.

- **Other new plants**—One of the newest and most complete environmental test facilities has just been completed at Goddard Space Flight Center. This facility cost $15 million. It can handle spacecraft weighing up to 4,000 lbs. and with a maximum size of 10 x 15 ft. It has centralized data-handling facilities, including a digital computer, for rapid processing of spacecraft test data.

New industry facilities include a space test system just installed by United Testing Laboratories for testing *Centaur* subsystems. The $300,000 system can simulate extreme cold, solar radiation, outer-space vacuum, and shock and vibration, singly or in combination.

Douglas Aircraft has begun work on a space systems center, to be developed over a 10-year period, which it says will be one of the largest and most advanced in the Free World. Privately financed by Douglas, the center eventually will occupy some 245 acres and provide over two million square feet of building space. Employment may well exceed 10,000 by the time all facilities are installed. The first major program scheduled for the center is the *Saturn IV-B*.

A principal feature of the center is a 39-ft. Earth-orbit simulator capable of testing full-scale spacecraft prototypes. This is scheduled for completion in October. Planned ultra-high-vacuum capability will provide for simulated pressure altitudes of 500 miles (10^{-12} torr). The center will include a centrifuge and spin-tumbler, vibration test bed, and cryogenic equipment for temperatures down to −320°F. High-vacuum chambers, solar-radiation simulator, and control room and instrumentation will also be incorporated.

Lockheed, in a different approach, has just entered the environmental testing business by making its $24-million *Polaris* and *Agena* test facility available to government and industry on a contract basis. ■

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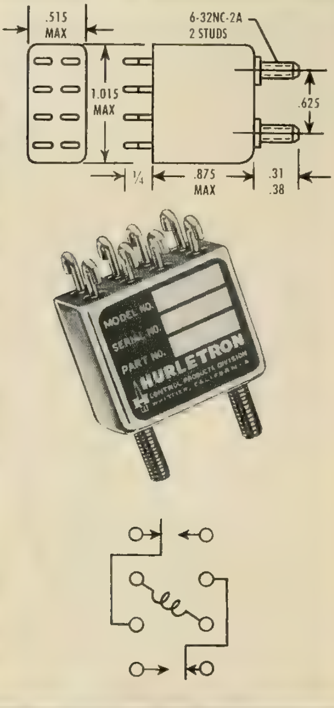

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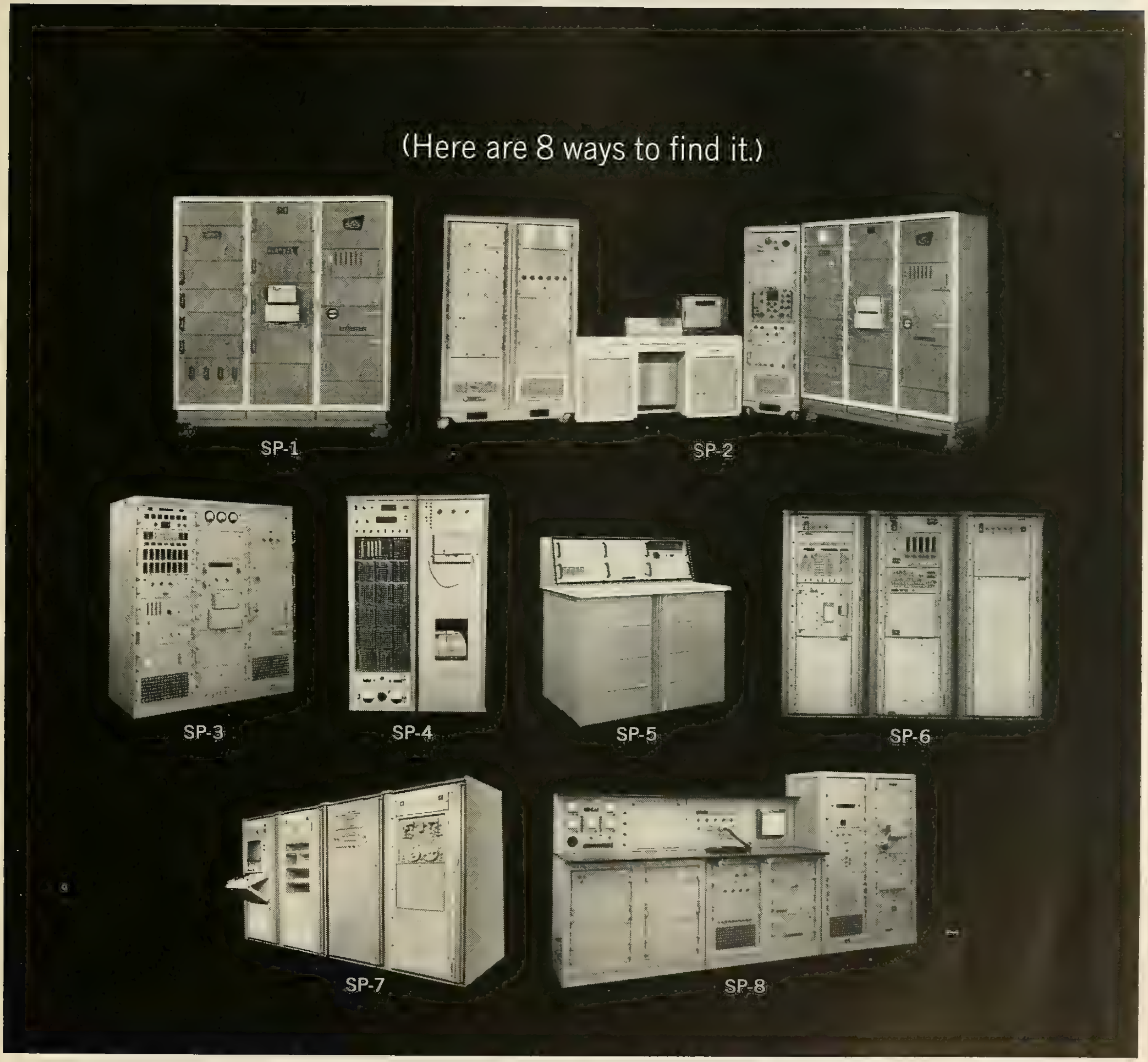

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Environmental Testing Spurs Industry

NASA ranks in-house test capability almost as important as production facilities in R&D contract deliberations

THE IMPACT of increased demands for environmental testing has triggered a chain reaction throughout industry. Prime contractors, faced with increased NASA demands, are passing them on to their suppliers, providing impetus for the spread of industry-built test facilities throughout the country.

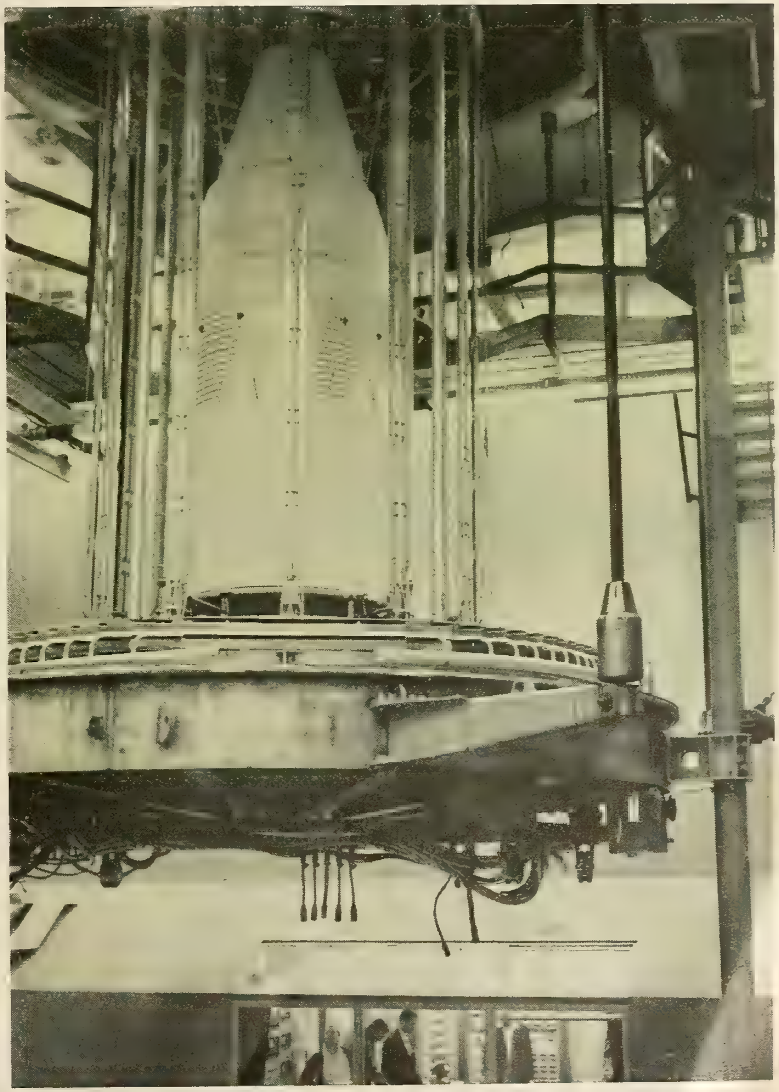
While having these facilities is no guarantee of winning a contract, a distinct disadvantage exists without them. NASA project officers rank in-house test capability almost as important as production facilities in considering a contractor for various R&D tasks.

Setting up environmental facilities is expensive. The requirement to run long-duration tests can tie up equipment for several months, thus many firms must invest in several different facilities and many duplicate test systems. The expense associated with these facilities, particularly for the small firms, has fostered the use and growth of a number of independent test laboratories.

The increasing number of test chambers of all sizes being installed around the country is also causing development of a new breed of test instruments to go inside the chambers.

The test equipment has to be inherently more reliable than the object under test, engineers point out, and certainly has to undergo as much testing as the spacecraft. For example, GE engineers disclosed that equipment going into the *Nimbus* test chamber at Valley Forge, Pa., has to be designed to inhibit outgassing, has to match thermal and radiation characteristics, use the same paints, have no air pockets, and use the same lubrication developed for components exposed to the space environment.

Three forms of environmental test are receiving considerable attention today in both missile and space system applications: shock, vibration, and solar simulation. A fourth—acoustical testing



SURROUNDED by heat panels that will simulate Sun's rays in space, a dummy Agena booster is raised into the full-scale vacuum chamber at Lockheed Missiles & Space Co.

—is growing in importance as boosters increase in thrust and size.

Here are a few of the problems associated with such testing and a brief summary of some new equipment approaches.

—*Shock and vibration*—Most vibration experts agree that there is a critical need to define vibration test procedures and specifications. Standardization of test methods is lacking. Different conditions of equipment create different distortion problems and basic inaccuracies in the test data. Specimens can successfully pass a test on one shaker and fail the same test on another.

J. P. Salter of Royal Armament Research and Development Establishment goes so far as to say that "the majority of shock and vibration tests are rooted in fiction." This fiction, he says, is so far from the truth that resulting tests are invalid. He contends that environmental engineers should follow the lead of radio engineers, who have faced up to the problems of complex impedances and the interaction of these impedances with each other.

C. M. Austin, quality evaluation laboratory manager for the Navy, concurs. He maintains that many vibration test specifications are conflicting and impractical. "We need research and rapid methods of up-dating specifications," he says, to reflect the results and constant review of test specifications.

Other experts also agree that many of the test specifications are invalid in terms of the equipment's operating environment. Some contend that shock testing is in even worse shape than vibration testing. These say that in many current missile/space systems, shock may well be the most critical environment to be considered. Yet equipment and procedures in use fall far short of requirements.

Shock tests give the environmental engineers trouble because the shock motion occuring in actual operation is complicated. Ideally, the only way to reproduce the shock motion in the laboratory is to actually reproduce the mechanism that creates the shock during service conditions. Also, equipment is often shocked many more times in actual operation than can be simulated in laboratory tests.

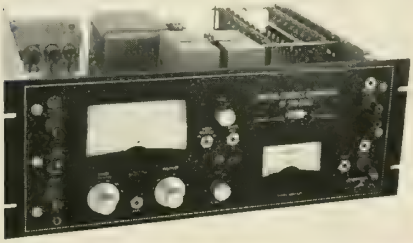
- **Simulation difficult**—The consensus is that it is practically impossible to realistically simulate shock and vibration environments. One suggested approach to a partial solution is use of mounting structures that are structural elements of the actual equipment chassis. This, at least according to one expert, would eliminate many of the uncertainties in shock testing.

Some progress is being made, however, in providing more realistic shock test equipment. Boeing, for instance, is building a new shock facility that will provide up to 200 g's on specimens weighing up to 2,000 lbs., with velocity changes of 300 fps, and forces of up to four million pounds. The facility includes an integrated digital data system and on-line computer, and automatic data acquisition, analysis, reduction, and presentation.

One of the most complex vibration systems yet designed is being built by MB Electronics for Aerospace Medical Laboratories at Wright-Patterson Air Force Base. This system, scheduled for completion this summer, will provide six degrees of freedom. It will be used to study the effects on astronauts of high-amplitude, low frequency, and linear and angular oscillation about three axes.

This unit will produce, with a 2,000-lb. load, linear oscillations in three directions and angular oscillation about three axes over the frequency range from zero to 30 cps, with a maximum linear acceleration of 20 g's. Maximum available displacement will be ±5 in. vertical excursion, ±15 degrees pitch and roll, and ±10 degrees yaw.

- **Advances in vibration**—Ling Electronics has come up with a unique



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approach to the requirement for ever larger vibration facilities. It applies the modular or multi-shaker array concept. By using a number of the smaller shaker units, practically unlimited force ratings may be obtained.

In addition, this approach provides a high degree of versatility. Ling also has just introduced a new shaker which, they say, is the only one that presently meets *Titan II* specifications. This unit can take 100 lbs. to 100 g's.

The Naval Ordnance Laboratory at Silver Spring, Md., has developed a unit called "vibration control accessory" for use with tracking filters which, they feel, will help considerably in vibration-distortion problems. Data errors are substantially reduced, and unexplained anomalies in vibration data are largely eliminated, they claim.

Other investigators agree that many of the inherent distortions in vibration testing can be significantly reduced by the use of tracking filters and RMS, or averaging-meter, circuits.

To reduce the sometimes intolerable time required to set up, mount, and install instrumentation and pre-test systems for vibration testing, Goddard Space Flight Center has made a significant innovation with its two 10,000 pound-force C-125 exciters.

By using a "switching cabinet," one of the big vibration exciters can be in operation while the second shaker is being set up. Use of a common control console and common amplifiers makes this possible. As soon as the first test item has been through its paces, the second shaker can be energized by push-button.

The operation is considerably faster and more efficient, NASA engineers claim.

- **Ranger refines art**—On its *Ranger* lunar capsule program, Aeronutronic Div., Ford Motor Co., engineers used a HYGE Model 347 to develop and test the balsa-wood input limiter that protects the inner instrument package from lunar impact shock.

The HYGE shock test machine, modified to a 550-in. stroke, has an output thrust of 500,000 lbs. of force. This shock test machine is a horizontal device, using a 52-ft. rail system. Typical shock pulses include a half sinewave shaker of 200 g's for 50 milliseconds, 300 g's for 35 milliseconds, and one-quarter cosine wave shape of 600 g's for 15 milliseconds. It can accommodate a specimen up to 28 in. x 36 in. and several feet long.

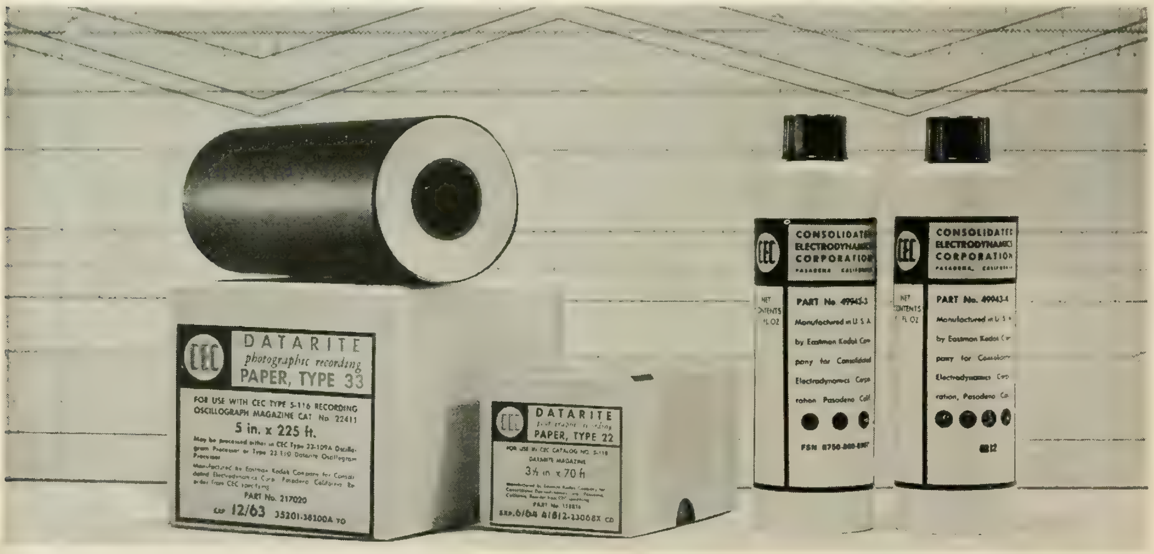
The sphere was accelerated to a constant velocity of 180 to 200 fps. (500 g's), and smashed against a rigid backstop. The backstop was held at 90° or 45° to simulate a head-on impact or impact at an angle on the lunar surface. "G" levels of approximately 3000 have been obtained with this technique, according to Aeronutronic.

Components are tested on a sled that rides tracks to impact against a balsa-wood limiter to shape the shock pulse. Plans to modify the sled and limiter to achieve more advanced test conditions are now in preparation.

—*Acoustical testing*—Duplication of the destructive force of the high-intensity noise generated by massive rocket engines has demanded new techniques and new equipment for acoustic testing.

To simulate the sound pressure levels of the *Saturn* engine, for instance, an acoustic system capable of the loudest sustained noise ever created by man was developed for the Marshall Space Flight Center. This facility, designed by Wyle Laboratories for NASA, uses a siren to produce a sound level of 167 lbs.—almost 100,000 times the level of ordinary room conversation.

Mounted in a 48-ft.-long horn built of one-foot thick concrete walls, the giant "loudspeaker" generates 30,000 acoustic watts to simulate the noise of the *Saturn-C-5's* 7½ million pounds of thrust. Installed last February, the facility cost $250,000. The reverberation test



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room measures 10 x 13 x 11 ft.—large enough to accommodate complete electronic consoles and other launch-site support systems.

The ordinary voice-coil loudspeaker can't reach such sound-pressure levels. A big enough voice coil would exert sufficient force to destroy the speaker cone, and the wall area of a test chamber wouldn't be big enough to hold the required number of cone speakers.

The point of diminishing returns is reached when more than one-fourth of available wall space is occupied by speakers. Such speaker systems have an upper limit of approximately 145 db. and 200-300 acoustic watts with efficiencies of 5-20%.

Sirens, too, have their limitations, principally in the fixed-spectrum output inherent in the rotor-configuration design. (The Marshall facility is designed to operate either with the broadband siren or a random/sinewave air-modulated driver.)

• **Useful developments**—Various configurations of electro-pneumatic transducers and reverberation chambers have been developed for larger and higher level acoustic testing facilities. Ling Electronics, for example, uses electro-pneumatic transducers in a progressive-wave tube to produce sound pressure levels of up to 170 db.

Ling has also developed a modular transducer unit that can be assembled in various-sized arrays to provide a highly versatile system in size and sound level to meet changing test requirements. One such system in use at Douglas Aircraft Co. uses 10 electro-pneumatic transducers in a progressive wave channel to produce 170 db. levels.

Bell Aerosystems Co.'s Acoustic Test Laboratory employs a variety of test chambers, including resonant, plane-wave, progressive-wave, and reverberation chambers.

The reverberation chamber is a 90-cu. ft., 10-sided, irregularly-shaped chamber that will accommodate components with volumes up to nine cubic feet and base areas up to 30 by 36 in. The system can develop an overall sound pressure level of 155 db., uniform with ±1 db., in the test section. It has a power input of 2,000 acoustic watts, providing frequency distribution from 20 to 20,000 cps.

The four low-frequency transducers are coupled to the chamber test section by a 23-ft.-long exponential horn, which varies in cross-section from three to five inches to 46 x 46 in. Clustered about the large horn on four adjacent sides of the chamber are 24 mid-frequency drivers with 15-in. long exponential horns, and 32 high-frequency drivers with four-inch connectors.

The chamber test section and 10

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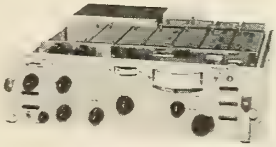

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LABORATORY technicians at new Space Environments Laboratory of Fairchild's Defense Products Div. prepare 15-ton vibration exciter for test in 3,000-cu.-ft. high-altitude temperature chamber.

feet of the large exponential horn are enclosed in a standard commercial four-inch-thick soundproof housing. The remaining 13-ft. portion of the large horn is covered with damping compound, fiberglass, and a plywood casing.

—*Solar simulation*—"A tremendous market with no money." This is the way one pundit describes the solar-simulation portion of the environmental testing industry. While this is not literally true, since many dollars are going into this area, there is evidence that the field is not mature.

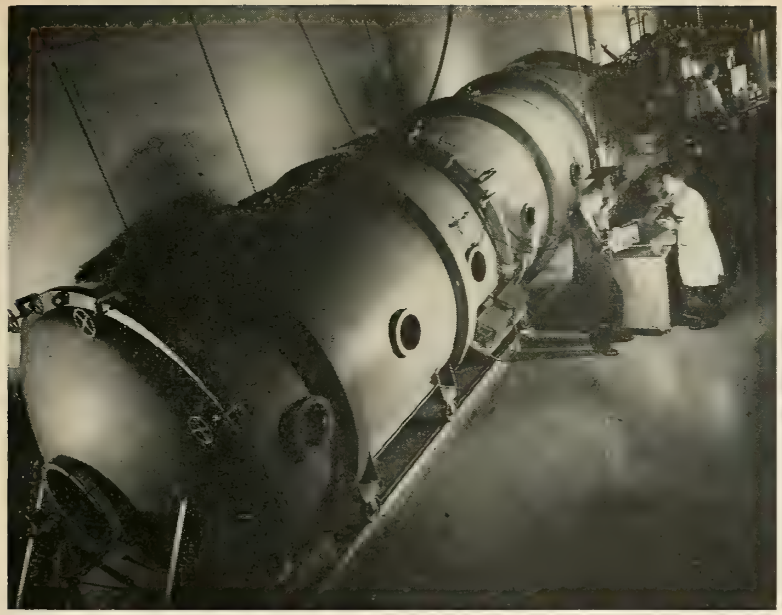
Another critic points out that the majority of environmental installations accept the limitations and problems of the ubiquitous carbon-arc simulator purely on the basis of cost advantage—which may represent a saving of 50% over a better system. Although this is commendable, he says, such a system is just not good enough for the requirements of a manned system.

Even so, the planned Houston Manned Spacecraft Center will rely on the carbon arc for thermal and solar-radiation testing.

- **Carbon-arc "Suns"**—Several different ways to simulate solar radiation are currently in use. The basic carbon-arc is the most widely used and has many proponents. Its main advantage is its low cost. The spectral distribution of the carbon-arc closely resembles that of the Sun, but with important discrepancies. Refinements have been made, but certain basic limitations are inherent. Among the disadvantages: relative instability, lack of cleanliness, and short operating time.

Some systems have improved certain of these disadvantages. Low efficiency (15%) and optics problems still remain. A lenticular lens system, such as used in the Arcomatic simulator, offers some improvement in density uniformity and up to 300% more radiant energy projection.

According to Bendix Corp., the carbon-arc simulator used in its 20 x 27-ft. chamber has several advantages. It offers good spectral energy match, they



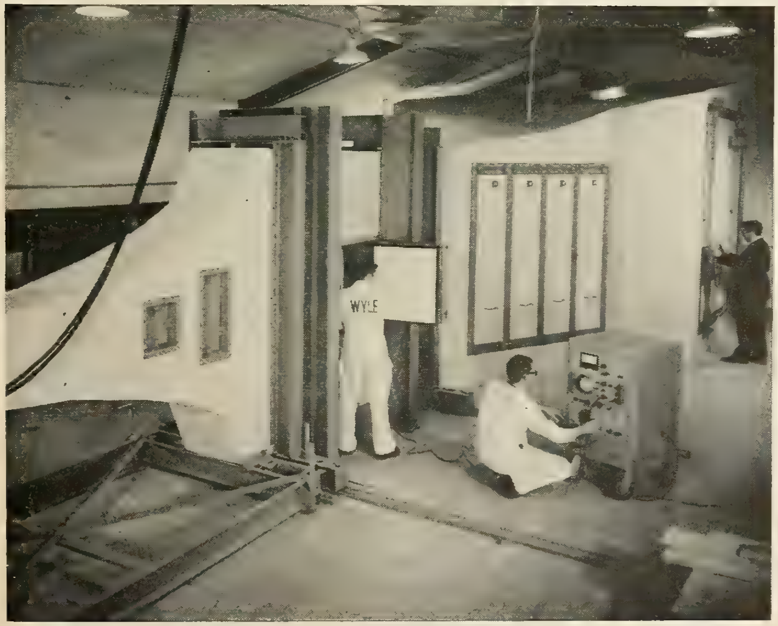
HIGH VACUUM facility in environmental test lab at Ford's Aeronutronic Div. closely duplicates certain atmospheric and thermal conditions of near space, aided in Ranger lunar capsule development.

say, as well as portability, adaptability, and higher intensity illumination per dollar invested than most other systems. Its major disadvantage is poor collimation. In any event, the company asserts, these performance trade-offs are necessary to maintain reasonable costs.

Several other disadvantages can be eliminated, users say, by design-evolution improvements in automatic loading, tighter arc control, and more efficient use of optical subsystems.

- **Other Sun simulators**—For certain areas of the solar spectrum, the xenon lamp, particularly in combination with other types, has found useful application. Such lamps provide clean operation and relatively long service life.

The mercury-xenon arc lamp combination approximates the solar spectrum very closely. Such systems require



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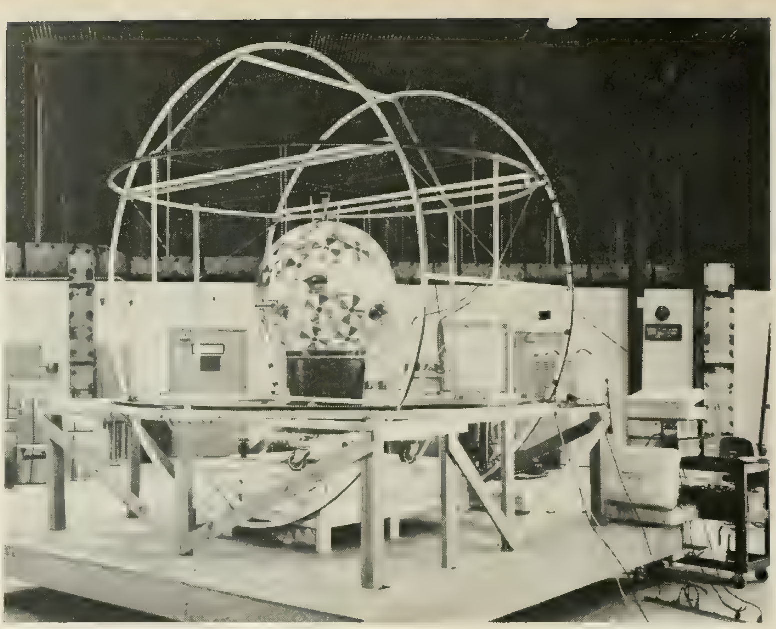


SPACECRAFT is shown in a Helmholtz coil test assembly at Space Technology Laboratories' Malibu, Calif., facility. A series of measurements is carried out to determine the structure's magnetic characteristics. STL will perform the magnetic properties determinations for NASA's Orbiting Geophysical Observatory program.

banks of individual lamps, however, and are relatively instable and short-lived.

Another source, used primarily for thermal simulation, is the tubular quartz filament lamp mounted in specially designed reflectors. These units can be easily installed in the test chamber. Incorporated in a circular grouping around the periphery of the chamber, the lamps can be programmed to rotate the maximum heat flux around the test specimen to accurately simulate satellite "night" and "day."

There is no one system in operation that offers all the desired characteristics: "acceptable" combinations of intensity level and gradients, collimation, and spectral match.

One of the most comprehensive solar radiation simulators available is built by the Aerospace Division of Tenney, Inc. This unit uses a simultaneous combination of three radiant

VACUUM TEST console in Propulsion and Vehicle Engineering Div., Marshall SFC.

sources: xenon, mercury-xenon, and tungsten-filament lamps. A complete optic system provides spectral distribution, uniformity, and collimation (± 2.5 degrees) that very closely approximates actual solar radiation.

A unique combination system has been designed for use in the Mark I simulator at Arnold Engineering Development Center. This system, developed by RCA, uses mercury lamps to supplement the basic carbon-arc in the ultraviolet portion of the spectrum. It also uses a complex arrangement of optics and reflectors, including a Cassegrain reflector. Only the final optics are inside the chamber. Seventy-seven of the solar-simulation modules are arranged in a vertical bank on one side of the test chamber.

The NASA Goddard facility uses still another method of solar simulation. There, 127 modules, mounted in the chamber dome, provide a 20-ft. dia. "Sun." Light sources are 2,500-watt mercury-xenon short-arc lamps mounted in a complex lens and reflector system. Provision has been made to replace these, possibly with 5,000 watt units. Overall efficiency is 15%.

This modular system is probably one of the most advanced to date. It pushed the state of the art in several areas, and consequently a number of problems developed in module design.

The principal problem was in obtaining the high-accuracy elliptical reflectors required. After considerable research and cut-and-try, suitable reflectors were obtained, but final evaluation awaits a substantial period of operational use.

Other problems involved thermal shock to the various optical elements, module alignment, (and lamp replacement), and various other temperature considerations.

- **Thermal models studied**—There is an urgent need for other solar-simulator improvements, particularly for better collimation, flux uniformity, and spectral content.

The problems of effective solar simulation grow with the size of the chamber. A number of U.S. research groups are looking into the possibility of using thermal modeling techniques to reduce the size of the spacecraft test model. This, in turn, could reduce the chamber size required for testing and allowing use of smaller, more accurate, and more controllable simulators.

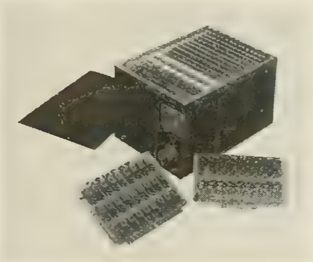
Feelings about the applicability of thermal modeling are mixed. Some engineers point out that the cost of effectively modeling a sophisticated interplanetary spacecraft will exceed the cost of developing improved solar-simulation techniques for large chambers. Others feel thermal modeling might have to be used for craft as large as *Voyager*. ■

IDS PROGRESS REPORT

252 CHANNEL AIRBORNE PCM TELEMETRY

Model 12-10 was developed and delivered in 90 days. This 420 cubic inch solid-state system features ± .2% accuracy from − 20°C to + 85°C and ± .1% accuracy from + 10°C to + 50°C.

The package includes a 90-channel primary multiplexer, a 135-channel subcommutator and a 45-channel subcommutator. Of the total 252 channels, 245 are data channels and 7 are used for frame synchronization. Sample-and-hold is provided for accurate measurement of ac signal voltages, and remote low-level subcommutation can be added with minor modifications.

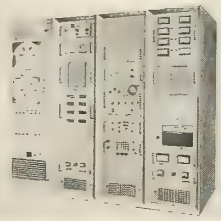


The digital data output — obtained from a compact A-D converter — is a 10-bit serial binary code which includes a nine-bit data sample plus a single bit for odd parity. The system weighs just 15 lbs. and consumes only 7 watts power. An optional r-f package designed specifically for Model 12-10 is available on request.

An IDS Technician checks out the PCM package using specially designed IDS test equipment. Each unit is individually checked for performance and workmanship and copies of test data are submitted with delivery.

COMPATIBLE GROUND PCM STATION

Design considerations for a modular, solid-state PCM ground decommutation station compatible with the Model 12-10 airborne equipment and other IRIG systems have been completed. The station accepts serial, PCM/FM telemetry data and furnishes digital, analog and quick-look readouts. It is capable of operation in subcommutation or super commutation modes and each major assembly is designed for mounting in standard 19-inch relay racks.



These examples have been selected from a broad capability. For further information, please write or contact our Marketing Manager.

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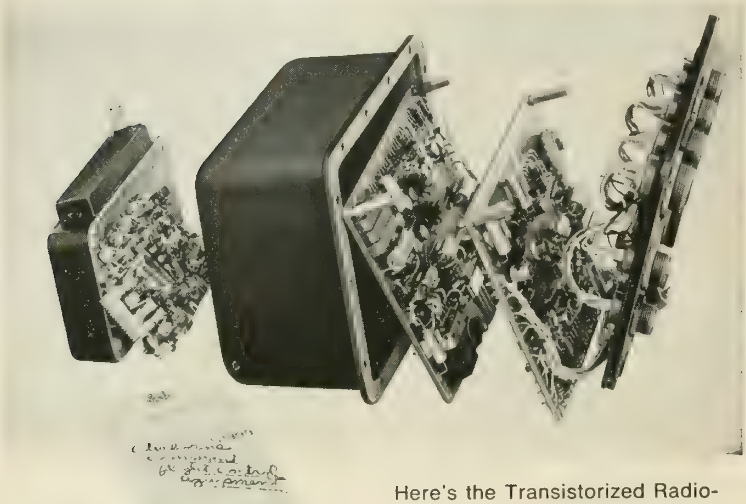
Transistorized

RADIO CONTROL UNIT Rates AOK-Fly at IEEE



Here's the Transistorized Radio-Receiving Control Set that impressed all visitors to the RS Electronics booth with its accessibility combined with a compact, functional design.

Remote control of pilotless aircraft and missiles is achieved with this airborne unit. It provides RSE solid state reliability with the efficient packaging offered by specially designed printed circuit boards.

Consisting of a proportional decoder Model 1301A and receiver Model 2624AT, this receiving set is operated in conjunction with an airborne gyro to provide automatic flight stabilization. Line-of-sight flights may be operated without the gyro. Parachute release can be actuated by command or automatically by loss of carrier. In addition to two proportional channels for attitude control, the decoder has one auxiliary control channel.

Extra command facilities are available by mounting compatible three, five, six or ten channel RSE decoders directly on the front panel of the Model 1301A with only slight space-weight increase. The basic Model 2624AT/1301A receiver-decoder measures 7⅝" high x 7¼" wide x 5¼" deep and weighs 4 lbs. 13 oz.

SPECIFICATIONS **Frequency:** Crystal controlled, preset to any frequency between 406 and 550 Mc. **Antenna Impedance:** 50 ohms. **Frequency Modulation:** ±120 kc per attitude tone; ±60 kc for auxiliary commands. **System Sensitivity:** 10 microvolts for simultaneous operation of the attitude command system and spare command channel. **L. O. Stability:** ±0.005%. **Selectivity:** Operation with 20 microvolt signal not affected by 0.01v CW interference at ±2 Mc from carrier. **Image Rejection:** 60 db. **Spurious Response Rejection:** 60 db.

For complete specifications on the Model 2624AT/1301A or other RSE equipment to satisfy special requirements, write to:

RSE RS ELECTRONICS CORPORATION

A Division of Pacific Industries, Inc.

795 Kifer Rd. • Sunnyvale, Calif. • Phone (408) 739-3230

7

Circle No. 36 on Subscriber Service Card

NASA Test and Checkout

(Continued from page 52)

checkout and launch equipment for *Centaur* R&D missions is designed for "engineer control." The equipment is semiautomatic with manual overrides. This leaves final go/no-go control to the judgment of the engineer, since he knows systems red-line limits and performance characteristics. NASA adds that use of military-derived first stages capitalizes on established techniques. However, they may extend the final 18-sec. *Atlas* countdown somewhat.

NASA also adds that, while computer-controlled automatic checkout is not used to any major degree on the vehicle, there may be some automatic guidance system checkout. In the guidance area alone, $5-10 million more is being spent on ground test. Reliability test environmental programs will be extended, components and subsystems will undergo higher-than-flight environment failure checks. NASA says the new lightweight and very accurate all-inertial *Centaur* guidance system represents a significant advance in this area and requires increased attention to the test program. Minneapolis-Honeywell, guidance prime, will augment its centrifuge facilities at St. Petersburg for these tests.

NASA reports it will use both telemetry RF link and hardwire connections to make the complete vehicle-payload checks at the Cape; however, they also point to problems of RF time and interference which may complicate timely use of RF methods at the launch site. *Centaur* was instrumented for 460 data points on the first flight.

Units that will actually fly will not be tested beyond flight levels; non-flight units will be so tested, to gather environmental, reliability, and mean-time-between-failures data.

- Two static test stands are now used in the *Centaur* development program. One is at GD/A's Sycamore Canyon test site near San Diego, and the second at Edwards Rocket Site, also in California. The stands accommodate *Centaur* test vehicles equipped with flight-type propellant supply and propulsion systems. Both stands employ a steam-diffusion system to develop a space-like vacuum around the *Centaur* engines during firing.

Additionally, a large vertical test stand at NASA Lewis Plumbrook test site is being modified to handle soft-suspension models of the *Atlas-Centaur-Surveyor* vehicle in tests to determine dynamic response to vibration inputs. NASA reports this has not been done before with the whole vehicle. The modifications are expected to be completed this fall.

Also at Lewis, the space power

chamber is being modified to provide a "cold wall" capability. *Centaur* flight models will be mounted inside for long periods to determine interaction of subsystems on the vehicle. NASA says it will use the flight-type vehicle now at the Cape as a ground test article for the Lewis tests. It cites the diversion of this flight article to ground test as indication of new emphasis on complete systems testing and as one reason for the long delay between flights.

The next flight of *Centaur*, powered by two Pratt & Whitney RL-10 engines, is slated for late in the third quarter of '63.

- **Ground instrumentation**—A large part of *Centaur* launch and test facilities is the ground instrumentation system. GD/A separates it into these general areas:

—*Measurement Acquisition*—Measurements originating at missile transducers are routed through umbilical cables to a ground junction box, then to a terminal rack where they are programmed into the instrumentation system wiring. Measurements originating in the various equipment areas are routed to a junction box located in each area, then to the terminal rack for programming. Measurements originating in the launch control equipment are routed directly from the various equipment racks or terminal racks to the instrumentation terminal rack.

—*Calibration and Conditioning*—This provides excitation to transducers, calibration voltages simulating transducer outputs, and signal normalization.

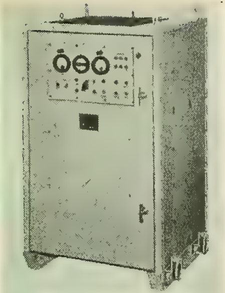
A voltage substitution (scale factor) scheme is the basic calibration philosophy for *Centaur*. A precision voltage in five steps is substituted for the measurement source (transducer, voltage, etc.) and the instrumentation system is adjusted to these limits.

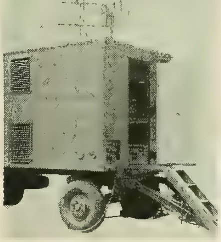
—*Recording*—Various types of recording are used, depending on measurement requirements. Null-balance type recorders are used for slowly varying (0-1 cps) signals to be monitored by test personnel as "redline" or operational parameters.

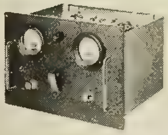
- **Vehicle weight and force measuring system**—In addition to vehicle weight information, this system indicates effects of wind loads on vehicle weight measurements. Primary measurements are taken during propellant loading operations.

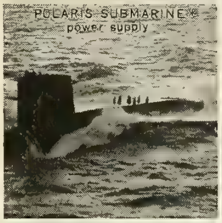
Closed circuit, remotely-operated TV also is provided at each site.

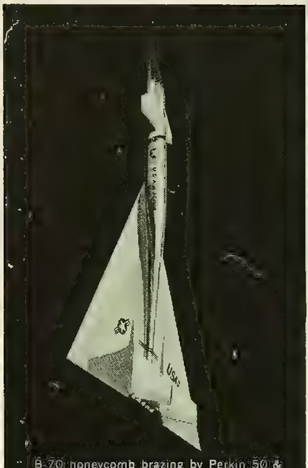
The viewing monitors and camera controls are located in the blockhouse area where they are accessible during hazardous conditions. Each camera position is equipped with remote iris, zoomer lens, and pan and tilt capability to complete system versatility. ■

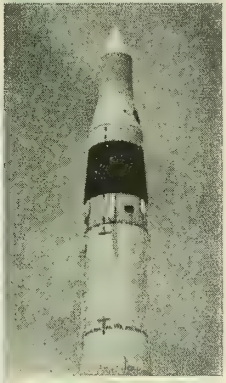


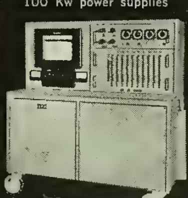


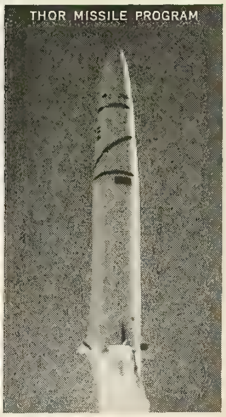












WIDEST RANGE .5 watt airborne radar (in hand) and part of 8000 Kw unit for Atomic Energy Commission (at left)

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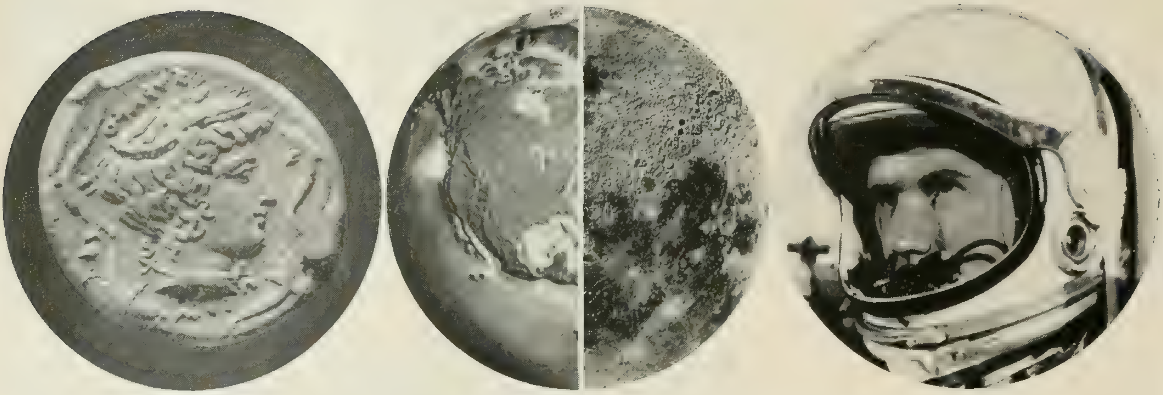

ACT NOW FOR ASSIGNMENTS ON PROJECT APOLLO

> *"The requirement for the Integration and Checkout program arises from the unique characteristics . . . of Apollo . . . which distinguishes it from other projects. These include (1) the serious consequences of failure as measured in terms of national prestige, human life and cost; (2) the complexity . . . in terms of the technology required and the numbers and types of industrial contractors involved; and (3) the long period of operations in the space environment with no significant maintenance or repair possible."*
>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

General Electric's Apollo Support Department has been selected to assist NASA in the integration support, checkout and reliability assessment of the Apollo system. Without doubt, it takes an unusually mature and competent man to perform under the realization that his individual work can be of significant importance to such a program.

If you are the kind of person who thrives on such responsible work, there's a place for you with General Electric. We've already put together the most impressive team ever assembled in the General Electric Company for this program . . . however, there are *many* opportunities still available to the *right* men. From the listings below you can determine your own opportunities. **Contract Programs:**

CHECKOUT . . . work consists of two distinct parts. First, a continuation of current engineering study efforts to provide NASA with checkout systems analysis, standardization studies, an integrated space vehicle checkout system specification, studies of test procedures, the application of advanced checkout techniques to Apollo, and system checkout engineering support at NASA field centers. Second, provision of checkout equipment to be included within the integrated launch control and checkout system.

RELIABILITY ASSESSMENT . . . effort includes assisting NASA in assessing overall mission reliability and safety levels, implementing a reliability and failure data system, and reviewing reliability and quality procedures and controls.

INTEGRATION SUPPORT . . . assist in identification and documentation of equipment and procedure interfaces within the Apollo project. Studies of integration methods and their application to Apollo including configuration control, and data handling.

The following types of engineering experience are needed in the above described programs:

Electrical • Electronics • Mechanical • Conversion and Guidance • Propulsion • Instrumentation and Communications • Telemetry • Pyrotechnic • Vehicle Systems • Systems Specifications and Designs • Digital Command Systems • PCM • Computers • Display • Analog and Digital Simulation • Test Simulation • Vibration Analysis • Space Mechanics • Operational Support Systems.

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The Industry Week

Industry Facilities

Edgerton, Germeshausen & Grier, Inc., Boston electronics firm, has broken ground in Bedford, Mass., for a three-building complex to house its corporate executive headquarters and R&D and engineering laboratories for the firm's eastern operations. The first of the buildings will occupy 165,000 sq. ft. Edgerton is presently working on flashing light sources for the *ANNA* satellite program and instrumentation and control for *NERVA* test stands. . . . *Physical Sciences Corp., a Packard-Bell affiliate, has moved from Pasadena to 314 E. Oak Ave., Arcadia, Calif. Floor space of the new plant is 14,500 sq. ft. and houses all company departments. PSC manufactures environment-resistant connectors and headers for missile, aircraft and nuclear applications, high temperature magnet wire, specialized transducers, instruments and systems.* . . . Space Age Materials Corp. has increased its Woodside, N.Y. manufacturing and laboratory facilities to 14,000 sq. ft. The company develops high temperature materials for missiles and spacecraft. . . . *North American Aviation, Inc., has established a new solid mechanics and mathematics research laboratory at its Columbus, Ohio, division. The new lab will be devoted to long-range applied research in advanced structural analysis, materials, dynamics, design and mathematics.* . . . The General Electric Co. has completed a large-scale manufacturing facility for producing voltage-tunable magnetrons at its Schenectady, N.Y., tube plant. Present VTM applications are in missiles, aircraft, electronic countermeasures, rapidly-tuned radar, test equipment, communications and telemetry. . . . *General Motors' AC Spark Plug Div. is adding 138,000 sq. ft. to its Milwaukee Operations. Construction on an 88,000 sq.-ft. manufacturing building and a 50,000 sq.-ft. two-story office building is to start this summer. Transfer of some administrative offices to the new building will permit expansion of existing engineering groups with increased need for missile/space R&D.* . . . United Technology Center, Sunnyvale, Calif., has established a Lancaster, Calif., office to direct company activities on the *Titan III* program at nearby Edwards AFB.

Mergers and Acquisitions

Michigan Wire Cloth Co. and missile/space-oriented Dynamic Filters, Inc., have merged and will operate as Michigan-Dynamics, Inc., with headquarters in Detroit. The predecessor companies will function as manufacturing divisions, with the parent corporation performing over-all management functions as well as coordinating research, development, engineering and marketing activities. . . . *Ling-Temco-Vought, Dallas missile/space and electronics firm, has sold Harbor Boat Co., Los Angeles, to Jack K. Weinstock and Alfred M. Feiler, engineers and consultants. LTV says the sale is in keeping with its decision to dispose of certain subsidiaries and product lines not within its primary fields of activity.* . . . Armour Alliance Industries, Alliance, Ohio, has acquired Standard Insulation Co., East Rutherford, N.J., manufacturer of plastic-reinforced laminates for missiles and aircraft, separators and insulators.

International

Hi-G, Inc., Windsor Locks, Conn., electronics firm, has formed Hi-G D'Italia, a subsidiary to begin manufacturing in Cisterna, Italy, next September. The Italian facility will aim at the NATO missile support market, offering hermetically sealed shock and vibration resistant relays and switching assemblies. . . . *Walter Kidde & Co., Inc., will exhibit aerospace and aviation systems and components at the 25th Salon International de l'Aeronautique et l'espace, June 6-16 at Le Bourget Airport, Paris. Kidde will be represented by two overseas subsidiaries, The Walter Kidde Co., Ltd., (England) and Walter Kidde G.m.b.h. (West Germany). The Kidde exhibit will include attitude and position control systems for satellite and missile applications.* . . . Standard Telephones and Cables, Ltd., British subsidiary of International Telephone and Telegraph, has installed safety alarm equipment valued at $280,000 at Berkley and Bradwell, Britain's first commercial nuclear power stations. STC is also supplying reactor safety equipment to a Trawsfynydd nuclear power station in North Wales and an extensive alarm system for a station in Latina, Italy. . . . *Conforming Matrix Corp., Toledo, Ohio, manufacturer of remote spray coaters for axial lead components, will base its export activities at the English-Speaking Union of the Commonwealth, Dartmouth House, 37 Charles St., Berkeley Square, London, effective June 1.* . . . General Dynamics/Electronics-San Diego has leased an S-C 4020 High Speed Computer Recorder to Great Britain's United Kingdom Atomic Energy Authority. Results of calculations on an IBM 7020 computer installed at the Atomic Weapons Research Establishment at Aldermaston, England, will be recorded by the S-C 4020 onto 35-mm microfilm or 9½-inch wide photorecording paper. The recorder utilizes electron beams to translate computer output into usable graphic form for management, engineers, and scientists. At electronic speeds, it converts digital language into curves, maps, drawings, charts or alphanumerics. . . . *United Aircraft Corp's. Norwalk, Conn., Norden Div. is associating with the Decca Navigator Co., Ltd., London in the development and manufacture of navigation equipment for military and commercial applications. As Decca's U.S. licensee, Norden will manufacture and sell Loran "C" equipment, developed by the English firm. Decca will provide technical assistance, and the two companies will exchange information concerning future product and marketing developments.*

contracts and procurements

AWARDS

AIR FORCE

$6,400,000—**Ets-Hokin and Galvin, Inc./Hood Corp.,** San Francisco, Calif., for *Minuteman* Wing V cable assemblies and installation at Francis E. Warren Air Force Base, Cheyenne, Wyo.

$1,900,000—**Hughes Aircraft Co.,** Culver City, Calif., for equipment for GAR-2B *Falcon* air-to-air missile. Work to be done at Tucson, Ariz.

$1,087,000—**Radio Corp. of America,** Burlington, Mass., for space research.

$1,000,000—**Aerojet General Corp.,** Sacramento, Calif., for research and development on Stage II *Minuteman* missile motors.

$1,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for research and development on large rocket motor cases.

$500,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for research and development engineering on electronic security systems to guard *Minuteman* missile sites.

ARMY

$6,138,888—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for continuation of research and development on *Shillelagh* missile system.

$5,379,007—**General Dynamics Corp., Pomona Div.,** Pomona, Calif., for continued development of the *Redeye* surface-to-surface guided missile.

$2,850,000—**Hughes Aircraft Co.,** Culver City, Calif., for research and development of a new missile system designed for use by the combat infantryman.

$2,230,139—**Intercontinental Manufacturing Co.,** Garland, Tex., for production of motor cases for the *Pershing* missile.

$1,900,000—**Sperry Utah Co.,** Salt Lake City, Utah, for continued performance of industrial engineering services on the *Sergeant* missile system.

$1,815,000—**Aircraft Armaments, Inc.,** Cockeysville, Md., for work on simulators used in training personnel on the *Nike Hercules* guided missile fire-control system.

$1,505,678—**Raytheon Co.,** Lexington, Mass., for continued production of parts and equipment for the *Hawk* surface-to-air missile system.

$877,000—**Bryson Construction Co., Inc.,** for rocket propellant mixer facility to be built at Redstone Arsenal, Ala., for use by the Rohm and Haas Chemical Co.

$688,000—**Allied Chemical Corp., General Chemical Div.,** New York City, for research on high-energy oxidizers for advanced solid-propellant rockets.

NAVY

$9,031,591—**Bendix Corp.,** Mishawaka, Ind., for *Talos* guidance control and airframe groups.

$9,000,000—**General Motors Corp., AC Spark Plug Div.,** Milwaukee, Wis., for inertial guidance system.

$6,900,000—**General Electric Co.,** Pittsfield, Mass., for *Polaris* missile fire-control systems.

$2,200,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Syosset, N.Y., for prototype static gyroscope research, development, technology and engineering.

$1,500,000—**Westinghouse Electric Corp.,** Pittsburgh, Pa., for design and production of reactor components for nuclear-powered ships.

$1,400,000—**Vitro Corp. of America,** Silver Spring, Md., for engineering services for *Typhon* missile system.

$1,200,000—**Bermite Powder Co.,** Saugus, Calif., for rocket motors.

$1,200,000—**Aerojet-General Corp.,** Azusa, Calif., for production of rocket motors.

$1,200,000—**Philco Corp.,** Philadelphia, for guidance and control components for *Sidewinder* air-to-air missiles.

$148,000—**Thiokol Chemical Corp., Reaction Motors Div.,** Denville, N.J., for research and development on heterogeneous propellant system for prepackaged liquid rocket motors.

$53,900—**Texas Instruments, Inc., Dallas,** for *Shrike* missile-system study.

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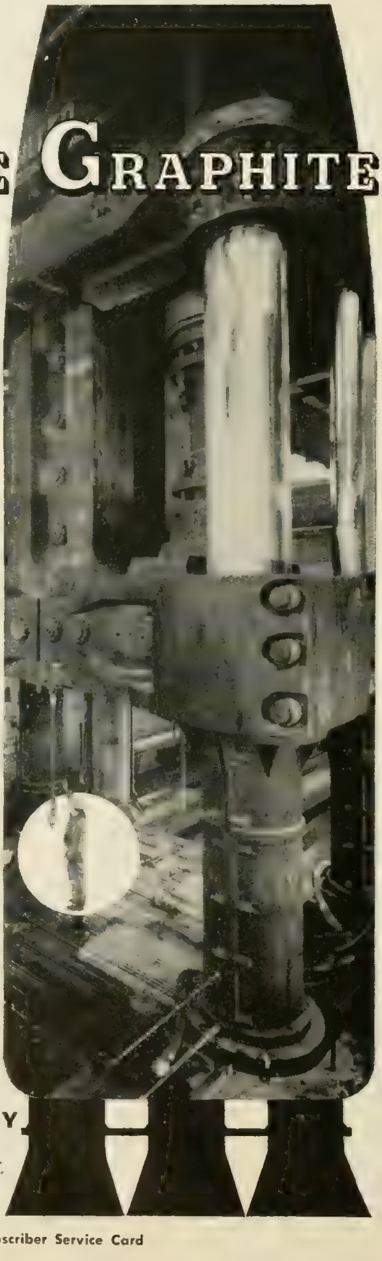

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Mail coupon to: MISSILE/SPACE DAILY, 1001 Vermont Ave., N.W., Washington 5, D.C.

NASA

$475,000—**Radio Corp. of America,** New York City, for production of solar cells to be used in the *Nimbus* weather satellite.

$423,000—**Aerolab Development Co.,** Pasadena, Calif., for *Argo D-4* sounding rockets.

$372,000—**Moog Servocontrols, Inc.,** East Aurora, N.Y., for servoactuators to be used to steer the booster stage of the *Saturn V Apollo* Moon rocket.

$100,000—**Northrop Corp., Space Laboratories Div.,** Hawthorne, Calif., for engineering studies of the biosatellite project.

$75,500—**Litton Systems, Inc.,** Beverly Hills, Calif., for a rigid space suit system.

$75,300—**Space General Corp.,** El Monte, Calif., for *Aerobee* sounding rocket components.

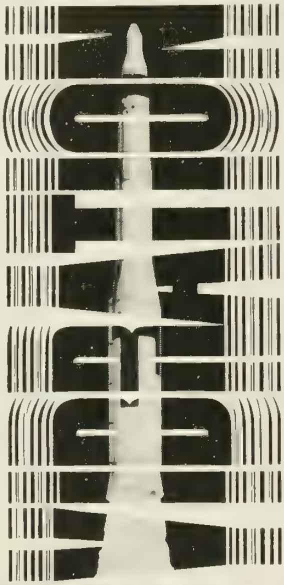
$29,600—**Varian Associates, Inc.,** Palo Alto, Calif., for rubidium vapor magnetometer services.

INDUSTRY

$1,000,000—**Garrett-AiResearch Div.,** Los Angeles, from **McDonnell Aircraft Corp.,** for the production of primary components designed to inflate the *Gemini* paraglider.

$231,000—**Radiation, Inc., Melbourne,** Fla., from **Martin-Orlando,** for 21 production models of a compact, high-speed strip printer for use in *Pershing* missile fire-control equipment.

$200,000—**Amphenol-Borg Electronics, Western Div.,** Chatsworth, Calif., from the **Boeing Co.,** for manufacture of a cable connector, a part of the umbilical system connecting the *Minuteman* missile to its ground support equipment.



TOTAL VIBRATION CAPABILITY AT UTL

With emphasis on Reliability, and a demanding need to provide high tolerance vibration environments, UTL offers one of the finest and largest vibration facilities in the Nation. ■ UTL's TOTAL CAPABILITY provides industry with a wide range of diversified vibration systems. Ten complete vibration systems with ratings from 100 force pounds to 30,000 force pounds are available for immediate use. ■ UTL takes pride in taking a responsible position to further the state of art in Close Simulation Environments. We offer a unique hyperenvironment space chamber, four feet in diameter and six feet in height, capable of being mounted directly to our 30,000 force pound vibration exciter or to a unique slip table, offering flexibility where hardware mounting attitude is of concern. The Space Chamber was designed to encompass the four most critical environments . . . Temperature (−320°F), Altitude (1 x 10-6Torr), Vibration (30,000 force pounds), Sine and Random, and Solar Radiation. ■ Another Close Simulation Environment is offered to those concerned with the simultaneous application of Radial Acceleration and Vibration. A 3500 force pound vibration exciter is mounted on a 10 foot radius centrifuge. Launch environments can thereby be simulated . . . steady state acceleration and complex vibration. ■ UTL customers have the advantage of extensive cost savings on testing programs utilizing the latest of automatic random programming systems, thus eliminating unnecessary equalization time and allowing greater confidence in reliability programs. ■ UTL vibration facilities are the latest in the state of the art for development, qualification and reliability testing.

Test Facilities: Call or write to the address nearest you.

- Monterey Park, California (Los Angeles Area), 573 Monterey Pass Rd., CU 3-4168
- Sunnyvale, California (San Francisco Area), 150 Wolfe Road, RE 9-5900
- Alexandria, Va. (Washington, D.C. Area), 4416 Wheeler Ave., 836-7200

A Division of United ElectroDynamics, Inc.
UNITED TESTING LABORATORIES

Circle No. 39 on Subscriber Service Card

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

High Altitude Section
Secondary Items Branch
Procurement Div.
Procurement and Production
Redstone Arsenal, Ala.

Propellant, Ordnance Part No. 10110182—1 item. To be procured sole source from Raytheon Co., Lexington 73, Mass., through Boston Procurement District, U.S. Army, Boston Army Base, Boston 10, Mass. Drawings in possession of contractor. Federal Stock No. 1337-987-6802—864 each. To be delivered to various destinations. Available specs, plans or drawings relating to the procurement described above do not fully provide all necessary manufacturing and construction details. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm. Procurement Request Order No. D1-3-L2554-O1-D1-A4. Request District Office be contacted for any additional information.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Electric thrust system, flight dynamics simulator and control programmer computer system. Job—RFP ADP-41; RFP due date 5-31-63.

Special Contracts Branch
Special Procurement Div.
U. S. Army Missile Command
Redstone Arsenal, Ala.

Selected source procurement for additional effort with Westinghouse Electric Co., Baltimore 3, Md., for improvements for the satellite tracking for the AN/FPQ-4 radar. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Solicits proposal for frequency standard, primary frequency, cesium referenced: National Co. Model NC-1501, atomichron or equal. IFB C-263-3. Bid opening 5-29-63. Contact bid officer, Mr. D. S. Phelps. Phone: 305, 783-7893.

National Aeronautics and Space Administration
Flight Research Center
P. O. Box 273
Edwards, Calif.

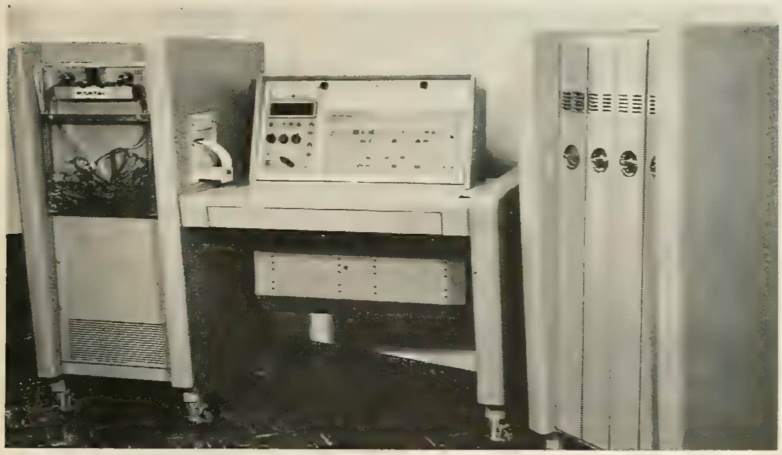
Negotiations will be conducted with Bendix Field Engineering Corp., Owings Mills, Md., for a short-term continuation of S/M to operate and maintain the NASA *X-15* high range. Note: For information only; no RFP available.

Control Systems Procurement Office
National Aeronautics and Space Administration
Manned Spacecraft Center
Houston 1, Tex.

Radio frequency signal level measurement program to be conducted at the Clear Lake, NASA Manned Spacecraft Center site. Job—RFP-MSC-63-640P. Copies of RFP will be honored for seven days from date of publication or until the supply is exhausted. Copies are available for reference in the control systems procurement office, NASA Western Operations Office, NASA Headquarters.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and materials necessary for designing, fabricating, instrumenting, measuring and reporting on physical properties and furnishing an aeroelastic ground windload model of a *Saturn IB* vehicle and associated umbilical tower in accordance with NASA Spec L-3522. Bidder must submit evidence with bid that his firm is currently or has been within the past 12 months directly engaged in the design and manufacture of aeroelastic and geometric models. IFB L-3522. Bid opening 6-3-63.



New Product of the Week:

Multipurpose Digital Control Computer

Martin Co. is marketing the MARTEC 420, a multipurpose digital control computer with provisions for 255 data inputs in either ac or dc form and 254 outputs, typically 28v dc up to 4 amps. The number of inputs and outputs can be tailored to fit any requirement by varying the units in multiples of 16.

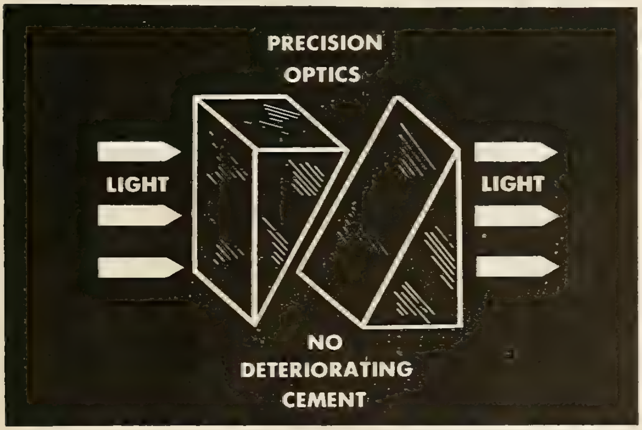
The design features fully integrated solid-state circuits, real time self-checking of all data transfer and decision circuits, central and remote unit operation, and ease of programming through an auxiliary program preparation unit needing no intermediate translation steps.

Aimed at checkout and control problems, the system can handle more than 100 different decisions based on test results with manual, semi-and full automatic operation available and punched tapes serving as built-in memories. The block data format solves programming problems in test terms, not computer terms, permitting engineers and technicians to program their own checkout routines.

Circle No. 225 on Subscriber Service Card

In keeping with the Test and Checkout theme of this issue's special report, the new products featured in these columns are equipment that can be applied in this important function in the missile/space field.

Are You Using Polarizing Optics . . .
With Deteriorating Cement In Your Laser Program?



Glan Prisms
Double Glan Prisms
Glan Thompson Prisms (mounted in precision divided circle)
Calcite Cylinder (up to 175 mm long)
Wollaston Prisms (from calcite & quartz)
Mica & Quartz Wave Plates
Rochon Prisms

Of course you're not (or shouldn't be)! Laser research programs in radar, communications, gyro guidance, IR, ultraviolet or computing demand the highest quality optical components. Any inherent deficiencies appear quickly in undesirable results. Quality, flawless components are the rigid and only rigid requirements to conduct research with a product from a undisputably reliable source. Listed below are some of the products available, and, in sufficient quantity, so results can be repeatable in other laboratory, or even production locations. Call, write, or wire for further information about your optical needs, including your optical problems.

OPTICAL SPECIALISTS
TO HELP SOLVE YOUR OPTICAL PROBLEMS
Karl Lambrecht, Owner
Crystal Optics
3959 North Lincoln Avenue, Chicago 13, Ill.
Area Code: 312 - Tel.: GR 2-5442-3-4

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HIGH RELIABILITY TEMPERATURE-SENSITIVE RELAYS AND FUSES

Hermetically sealed in glass by NETWORKS' Patented "Metal-to-Glass" original process . . .

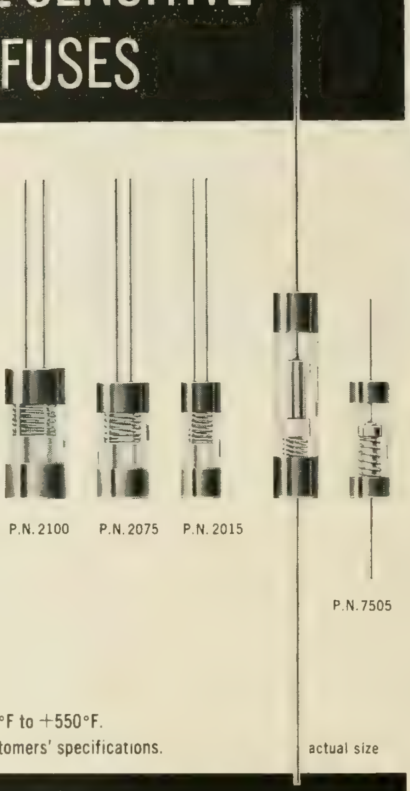
The sealing of Kovar-to-glass headers to the ends of pyrex tubing ensures:

- Interior visibility
- Effective resistance to humidity and salt spray
- Increased mechanical strength.

OPERATION

These units are normally closed SPST one-shot switching devices. They are non-resettable, incorporating a sensitive element that abruptly changes from a solid to a liquid state at a specified temperature. Positive contact before operation and positive breaking of the current at the instant of operation are both assured by the action of compressed springs.

OPERATING TEMPERATURE RANGE: +150°F to +550°F.
TEMPERATURE RISE (°F/Minute): Per customers' specifications.



TYPICAL CHARACTERISTICS	RELAYS 2000 SERIES				FUSES 7500 SERIES	
	2015	2040	2075	2100	7503	7505
ELECTRICAL:						
Current Rating (Amps)	1.5	4.0	7.5	10.0	15.0	5.0
Hi-Pot (max. at sea level)	600 VRMS — 60 cps				600 VRMS — 60 cps	
Max. Applied Voltage to Fuse	600 VRMS — 60 cps				600 VRMS — 60 cps	
Insulation Resistance	1000 megohms min./500 VDC				1000 megohms min./500 VDC	
Contact Resistance	0.3 ohms max.				.005 ohms max.	
Resistance (after Firing)	50 megohms min.				50 megohms min.	
ENVIRONMENTAL:						
Ambient Temperature	—100°F to operating temp.				—100°F to operating temp.	
Shock for 2-4 msec.	100 G's				50 G's	
Vibration	20 to 1000 cps at 20 G's				20 to 500 cps at 15 G's	
DIMENSIONAL:						
Body O.D. (inches max.)	.250	.250	.325	.375	.285	.250
Body Length (inches max.)	.72	.72	.72	.80	1.25	.70
Lead Dia. (inches)	.020	.030	.040	.050	.050	.032
Lead Material	Kovar		Kovar-clad copper		Copper	

NOTE: Special characteristics other than those shown above can be furnished to fulfill your specific requirements.

Write, wire, or phone for additional information.

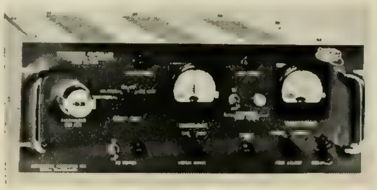
NETWORKS ELECTRONIC CORP.
9750 DE SOTO AVENUE • CHATSWORTH, CALIF. • DIAMOND 1-0440 • TRIANGLE 3-6600

Circle No. 40 on Subscriber Service Card

Gyro Temperature Controller

Aerospace Research, Inc. is marketing a dynamic gyro temperature controller and thermistor calibrator. Designated the TC-100, the unit is capable of holding the gyro temperature to a stability of 0.05°F irrespective of temperature changes in the gyro test area. The TC-100 is also used to calculate gyro thermistor padding resistances prior to field installation.

The instrument operates in three modes to allow rapid testing under both fixed and variable temperature conditions. The preheat mode automatically brings the gyro damping fluid up to operating temperature. The control mode may then be used for constant temperature gyro testing. The cycle mode provides an efficient check of gyro dynamic temperature sensitivity and a rapid measurement of temperature drift. The nominal cycle time is 8 min. during which the gyro temperature is sinusoidally varied. Both the cycle period and the temperature range are easily adjusted to match individual gyro specifications.



Circle No. 226 on Subscriber Service Card

Frequency Multipliers

LEL, Inc., is marketing a line of high efficiency varactor frequency multipliers. Operating at frequencies from 125 mc to 10 kmc, these multipliers may be used as single units or cascaded to provide any multiplication to desired frequency. Standard doublers and triplers with typical 60% efficiency are available now at power levels up to several watts and spurious rejections of 20 db to 30 db. These units are factory tuned to exact frequency requirements

Circle No. 227 on Subscriber Service Card

Delay System

Computer Devices Corp. is marketing a high-stability magnetostrictive delay line system for use as a range calibration standard in phase sensing airborne tracking and communication systems.

The MS-400 is a unity gain delay system which provides 7 delays to a 70 kc continuous wave signal. Delay is selected by means of an 8 position selector switch providing a choice of delay settings from 100 to 6000 microseconds. It accepts a 70 kc modulated sine wave signal of 1 to 1.5 VRMS amplitude and puts out a delayed signal which is adjustable between 1 and 2 VRMS.

Circle No. 228 on Subscriber Service Card

Short-Focus X-Ray Tube

The lowest X-ray focus in portable radiographic equipment has been incorporated in General Electric's recently redesigned LX-140 unit. The G-E tube in the portable machine projects its radiation output within a 0.8-mm focus diameter, about half the projection of the LX-140's former tube and the only focus of less than a millimeter in self-contained units such as the LX-140.

Corresponding sharpness in radiographically recorded detail is the result. The micro-focus tube is also adaptable as a replacement item for non-GE machines of LX-140 class.

The LX-140 in which the tube is presently used has a continuous rating of from 70 to 140 kilovolts peak at 2 milliamperes. It produces radiographs of 2% sensitivity and 1.5 density through steel 1¼" thick in less than 30 sec.

Circle No. 229 on Subscriber Service Card

Digital Event Recorders

Packard-Bell Computer will market two versions of its Digital Event Recorder. The two models developed by Packard-Bell are the DER-600, with a maximum 600-channel capacity and the DER-2000 for monitoring up to 2000 channels.

Both models of the Digital Event Recorder operate at 100 kc, sequentially scanning up to 2000 channels in 2 milliseconds and printing or reading out the time, direction and channel number of any changes in channel status. Output can be into a line printer, paper tape punch or high speed buffer for transfer to magnetic tape or direct input to a computer.

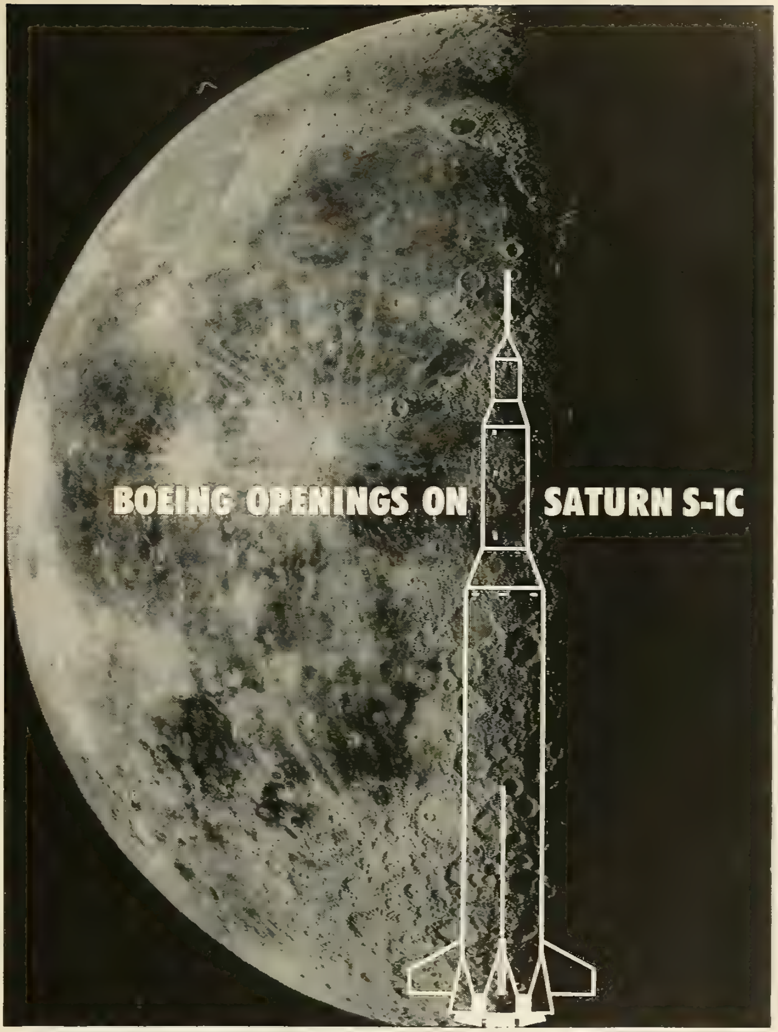
Other features of the device include the fast cycling rate and event backlogging which permits sensing, storing and subsequent read-out of events occurring faster than output devices could normally handle them.

Circle No. 230 on Subscriber Service Card

Cold Chambers

A line of general purpose cold chambers is being marketed by Scientific Columbus, Inc. The thermoelectric cooled chambers (the GPC Series) are available in several models, all of which operate with an input current of 10 amps or less. The line includes one model which operates directly from automotive or marine electrical systems. Other chambers, operating up to 30 amps, are also available.

Circle No. 231 on Subscriber Service Card


BOEING OPENINGS ON SATURN S-1C

Boeing has primary developmental, building and test responsibility for NASA's Saturn S-1C advanced first stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: structural design, electrical/electronics, propulsion, aeronautics, systems test, mechanical design, industrial, manufacturing, facilities, high vacuum, astrodynamics, cryogenics and thermodynamics.

Salaries are commensurate with all levels of education and experience.

Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly-hired engineers.

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn, and other missile and space programs at Boeing – including the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle – are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

Send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088-MSL, New Orleans 26, Louisiana. An equal opportunity employer.

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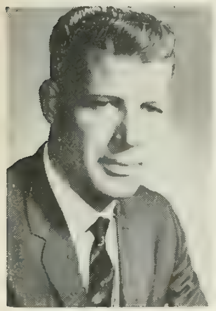
Divisions: Military Aircraft Systems • Transport • Vertol • Industrial Products • Boeing Scientific Research Laboratories

names in the news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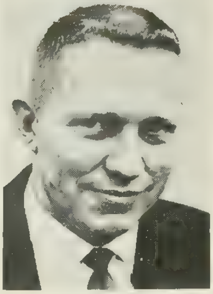
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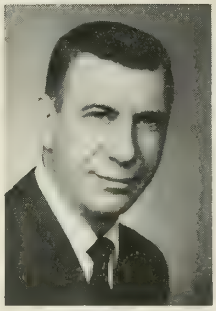
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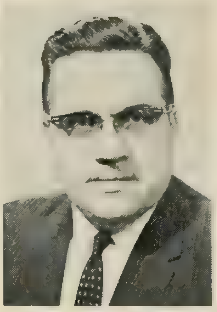
VERGEICHIK

Leonard J. Heilman: Elected president of General Technology Corp., Torrance, Calif.

Paul A. Deegan: Named director of administration for Avco Corp.'s Lycoming Div., Stratford, Conn.

John Vergeichik: Appointed director of the microwave equipment laboratory of the ACF Electronics Div. of ACF Industries, Inc., Paramus, N. J.

Bernard Bernstein: Appointed manager of the projects department, United Earth Sciences Div. of United ElectroDynamics, Inc., Pasadena, Calif.

George E. Johnson: Named chairman of the board at Houston Fearless Corp., Los Angeles. **Fred C. Mehner** elected president and chief executive officer.

Electronic Talyvel

checks level to distance of 300 feet

The Talyvel is a precise, completely portable level, battery operated. An electronic displacement signal, transistor-amplified, is fed to a zero-center meter. The meter is scaled in both angular and linear measures to indicate exact tilt of level. The pointer comes to rest in about 1 second of time; repeatability is at 1 arc second.

The Talyvel is designed for use in the many places where reading a block level is difficult. The instrument is particularly valuable for checking machine tools and launchers for missiles and rockets; for releveling and adjustment control.

For complete information, ask for Catalog TM-53

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Mervyn B. Dagneau: Elected president and member of the board of directors of Reinhold Engineering and Plastics Co., Inc., Santa Fe Springs, Calif.

Charles J. Feeney: Appointed Northeast regional manager for Philco Corp.'s Western Development Laboratories, Palo Alto, Calif.

Ivan F. Weeks: Appointed senior staff scientist to the director, Office of Research, San Bernardino, Calif., Operations of the Aerospace Corp. **George C. McKoy** appointed manager, systems analysis and instrumentation ATHENA Program Office.

William E. Achor: Appointed president of the Ideal-Aerosmith Div. of Royal Industries, Inc., Cheyenne, Wyo.

Steve D. Truhan: Named director-vehicle flight readiness of the Douglas Missile and Space Systems Div., Santa Monica, Calif.

Kenneth B. Boothe: Named manager of sales for Vitro Electronics division of Vitro Corp. of America, Silver Spring, Md.

Charles W. Sherman: Elected vice president-operations of Vanadium-Alloys Steel Co., Latrobe, Pa.

Gene Hegedus: Appointed engineering manager of the Mechatronics Div. of Servomechanisms/Inc.

James H. Gurley: Appointed manager of Army requirements for General Dynamics/Electronics, San Diego.

Harold H. Rhodes: Appointed executive vice president of Matrix Electronics Corp., San Diego.

Kenneth R. Jackson: Named assistant general manager of the Computer Div. of Packard Bell Electronics, Los Angeles.

John T. McGraw: Elected vice president of Royal Industries, Inc., Pasadena, Calif.

Robert J. Weismann: Named manager of engineering for Ampex Corp.'s video and instrumentation division, Redwood City, Calif.

Rear Admiral Daniel V. Gallery (USN ret.): Joined Kollsman Instrument Corp., Elmhurst, N. Y., as Naval Consultant to the president.

William O. Sweeny: Elected president and chief operating officer of the Arwood Corp., New York City. **Dorothy M. Stagg** elected secretary. **Stanley M. Babson, Jr.** named vice president of finance. **William I. Matthes** named vice-chairman of the board, and **Harry Matthieson** elected to the board.

Howard T. Steller: Appointed general manager of the Sierra Operations of Philco Corp.'s Lansdale, Pa., division.

William F. Wells: Joined the Perkin-Elmer Corp. as general manager of its Electro-Optical Div., West Coast Operations, Costa Mesa, Calif.

B. F. Raynes: Elected executive vice president of the Rohr Corp., Chula Vista, Calif. **Charles E. Cantwell** appointed manager of the Riverside, Calif., operation.

Kenneth A. Jackson: Appointed supervisor of manufacturing engineering for the Williamsport, Pa., operations of the Microwave Device Div. of Sylvania Electric Products, Inc.

Nicholas F. Pensiero: Appointed manager-marketing services, Defense Electronics Products Div., Radio Corp. of America, Camden, N. J.

James S. Rice: Elected vice president and general manager of the Curtiss Div., Curtiss-Wright Corp., Caldwell, N. J.

Dr. Charles J. Martell: Joined Spacelabs, Inc., Van Nuys, Calif., as assistant medical director.

Kenneth Zeitz: Appointed marketing manager of the Defense and Space Div., Air Products and Chemicals, Inc., Allentown, Pa.

Charles A. Zwissler: Appointed development engineer for Kaiser Steel Corp.'s General Sales Div., Oakland, Calif.

William H. Wall: Appointed vice president of administration of Lear Siegler, Inc.'s Astro Structures Div., El Segundo, Calif.

Albert P. Smith: Appointed manager of engineering for United AeroSpace Div. of United ElectroDynamics, Inc., Pasadena, Calif.

Uryon S. Davidsohn: Named director of the Physical Electronics Div., Radiation, Inc., Melbourne, Fla.

Ralph F. Woodward: Named quality control manager, Manufacturing Div., Warnecke Electron Tubes, Inc., Des Plaines, Ill.

Max Golden: Appointed special assistant to the president of General Dynamics Corp., New York City.

Lt. Col. Peter W. Branch (USAF ret.): named director of marketing/quality control, Southern Electronic Engineering Co., Warner Robins, Ga.

J. Harry Frankfort: Named area manager, Project Development Dept., Vitro Engineering Co., New York City.

Thomas J. Hanlon: Appointed head of the publications branch of Cornell Aeronautical Laboratory, Buffalo, N.Y. **Joseph T. McCarthy** named head of the public relations group.

REMOTE DATA RETRIEVERS, EVENT AND DATA RECORDERS

117.50
121.00
122.99
127.99

PRINT AND PLOT SIMULTANEOUSLY

SPECTRUM ANALYSIS, DENSITOMETERS, FACSIMILE RECORDERS

HOGAN FAXimile recorders are available with up to 2000 individual styli for simultaneous recording. A wide range of stylus spacings is offered—up to 100 to the inch for high-speed facsimile, television and radar recorders and high resolution printers and plotters. Chart widths to 30″ and feed rates to 50″ per second.

Hogan specializes in electrolytic techniques for event, spectrum analysis, oscillograph and facsimile recording, frequency time analysis and special purpose binary and gray scale record applications. Hogan electrolytic recording papers provide a permanent high contrast black on white record which is reproducible on most conventional office duplicators.

Whatever your recording problem may be — contact *HOGAN FAXimile, a subsidiary of TELautograph Corporation, 635 Greenwich Street, New York 14, N.Y.*

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A SUBSIDIARY OF TELAUTOGRAPH CORPORATION

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VACUUM
INSULATED
PIPE

Send for our brochure.
THE COSMODYNE CORPORATION
Hawthorne, California

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Engineers

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A variety of new positions have been established in the expanding scientific effort of a United States Government Agency engaged in vital national security activities. Openings encompassing a wide range of salaries and specialties exist in programs involving advanced research, development and technical operations including the areas of solid state physics, sensors and sensor systems, microwave, radar, operations research analysis, systems research and analysis, digital circuit analysis, computer techniques. An opportunity, unique to scientists and engineers, for a satisfying, dynamic and challenging career. Washington, D.C. area. Send resume to Box 146, Suite 1200, 230 West 41st St., New York 36, N.Y.

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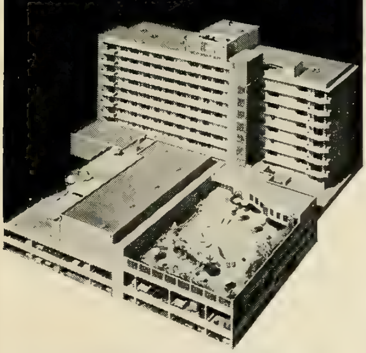

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Lunar Surface Materials Conference, sponsored by Air Force Cambridge Research Laboratories and A. D. Little, Inc., Hotel Somerset, Boston, May 21-23. (Restricted)

Institute of Electrical and Electronics Engineers, Seventh National Conference on Product Engineering and Production, Continental Hotel, Cambridge, Mass., May 27-28.

JUNE

Third Annual Reliability Institute, University of Connecticut, Storrs, Conn., June 2-14.

SAMPE Symposium on Space Power Systems Materials, Bellevue-Stratford Hotel, Philadelphia, June 3-5.

COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland, June 3-11.

Symposium on the Exploration of Mars, sponsored by the American Astronautical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections and NASA, Denver Hilton Hotel, Denver, June 6-7.

25th French International Air Show, Le Bourget, Paris, June 7-16.

Reliability Training Conference, sponsored by American Society for Quality Control, The Bishop's Lodge, Santa Fe, N. M., June 10-14.

Symposium on Plasma Space Science, supported by NASA and Goddard Space Flight Center, Catholic University of America, Washington, D. C., June 11-14.

AIAA Heat Transfer and Fluid Mechanics Institute, California Institute of Technology, Pasadena, June 12-14.

American Society for Testing Materials Annual Meeting, Purdue University, Lafayette Ind., June 13-18.

AIAA Summer Meeting, Ambassador Hotel, Los Angeles, June 17-20.

Institute of Electrical and Electronics Engineers, Summer General Meeting, Toronto, Canada, June 17-21.

American Nuclear Society Annual Meeting, Gatlinburg, Tenn., June 20-24.

American Institute of Electrical Engineers Summer General Meeting, Fountainebleau Hotel, Miami Beach, June 20-25.

Institute of Space Communications, sponsored by the University of Maryland with the cooperation of the Goddard Space Flight Center, University of Maryland, College Park, Md,. June 23-28.

66th Annual Meeting of the American Society for Testing and Materials, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., June 23-28.

Symposium on the Problems and Application of Dielectrics in Space, Westinghouse Research Laboratories, Pittsburgh, June 25-26.

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editorial . . .

Test and Checkout

ONLY NOW is the full impact of test and checkout on U.S. spacecraft programs beginning to be fully appreciated. It is not yet generally realized that the financial outlay for test and checkout of the *Saturn* will be so vast that it will affect not only the *Apollo* program but also the design of future spacecraft which will use the big booster.

The sheer magnitude of the expenditure is bringing about an enforced standardization of vehicles to fit the test and checkout structure. This can affect so many facets of spacecraft design that double care must be taken in laying out the initial parameters for the test and checkout equipment.

There are two important goals of the present effort:

- To reduce time on the pad.
- To increase reliability in space.

The background of experience in a number of programs, both civil and military, is being employed to reach these objectives. *Polaris* test experience, for example, will have its impact on *Saturn* philosophy. In fact, much of the equipment in the *Saturn* test and checkout structure will not be new. But an entirely new design philosophy—particularly in the use of computers—is required by the project. Success in solving the man-machine relationship will dictate much of the success of *Saturn-Apollo* test and checkout.

Two programs are having a strong influence on current test and checkout design. One, of course, is *Apollo* itself. Its manuals will set standards for the programs which follow. Final decisions affecting both ground and in-flight testing are evolving gradually in such areas as digital computer-controlled checkout. Although no state-of-the-art breakthroughs are required, NASA also is looking for improvements in a number of other technical fields. All in all, it will be a lucrative and challenging market for those firms which are in it early.

The other program which is strongly affecting test and checkout procedures is *Centaur*. The unhappy early record of *Centaur* brought a new appreciation for the values to be obtained by a carefully planned test and checkout program.

As a result, the ground test program for *Centaur* has been stepped up by some 800%—to the point where it will be, in the words of one NASA official, "the most thoroughly tested space vehicle in history."

At a cost of nearly $7 million, a Combined Systems Test Stand is being erected in San Diego to check out an entire *Atlas-Centaur* with its *Surveyor* spacecraft. All three stages will be mated electrically and then tested under mission conditions.

"As far as the vehicles are concerned, they will be operating on an actual flight to the Moon," says Grant L. Hansen, *Centaur* program manager for General Dynamics/Astronautics.

Thus, it will be possible to determine that all systems are compatible and functioning properly before shipment to the Cape. This will reduce time on the pad to a point where mission capability for *Centaur* eventually will be one per month—and it also will do much to improve reliability.

An earlier appreciation of the importance of test and checkout might have been a big step toward elimination of preflight and in-flight failures of vehicles such as *Centaur* and *Ranger*. An investment in ground facilities for this purpose can mean a savings in expensive boosters and spacecraft.

But the $7 million for the new San Diego facility may be only a start. Already, NASA is considering a complete environmental chamber in Nevada for testing the entire RIFT stage. This would require a truly massive vacuum chamber, capable of holding a stage 150 ft. high and 33 ft. wide.

Cost? In the neighborhood of $60 million.

Nor is future investment to be limited to giant facilities such as this. Much remains to be done in the area of test equipment itself. Lack of accurate measuring devices can hamper testing. This is particularly true today in vacuum and light measurement.

Many engineers have pointed out the need for better standards in establishing test equipment specifications. A vacuum chamber capable of reaching 10^{-15} torr is limited in its practical value if there are no instruments to measure that vacuum and there is no test equipment capable of functioning in it.

Engineers also are hoping for Dept. of Defense-NASA standardization for such system parameters as prime voltage sources, data monitoring levels and logic levels for digital systems. There is a need for improved solar simulators.

More attention must be devoted to all of these important test and checkout areas. But even so, there must eventually be a limit. The jump from $7 million to $60 million cannot be extrapolated indefinitely.

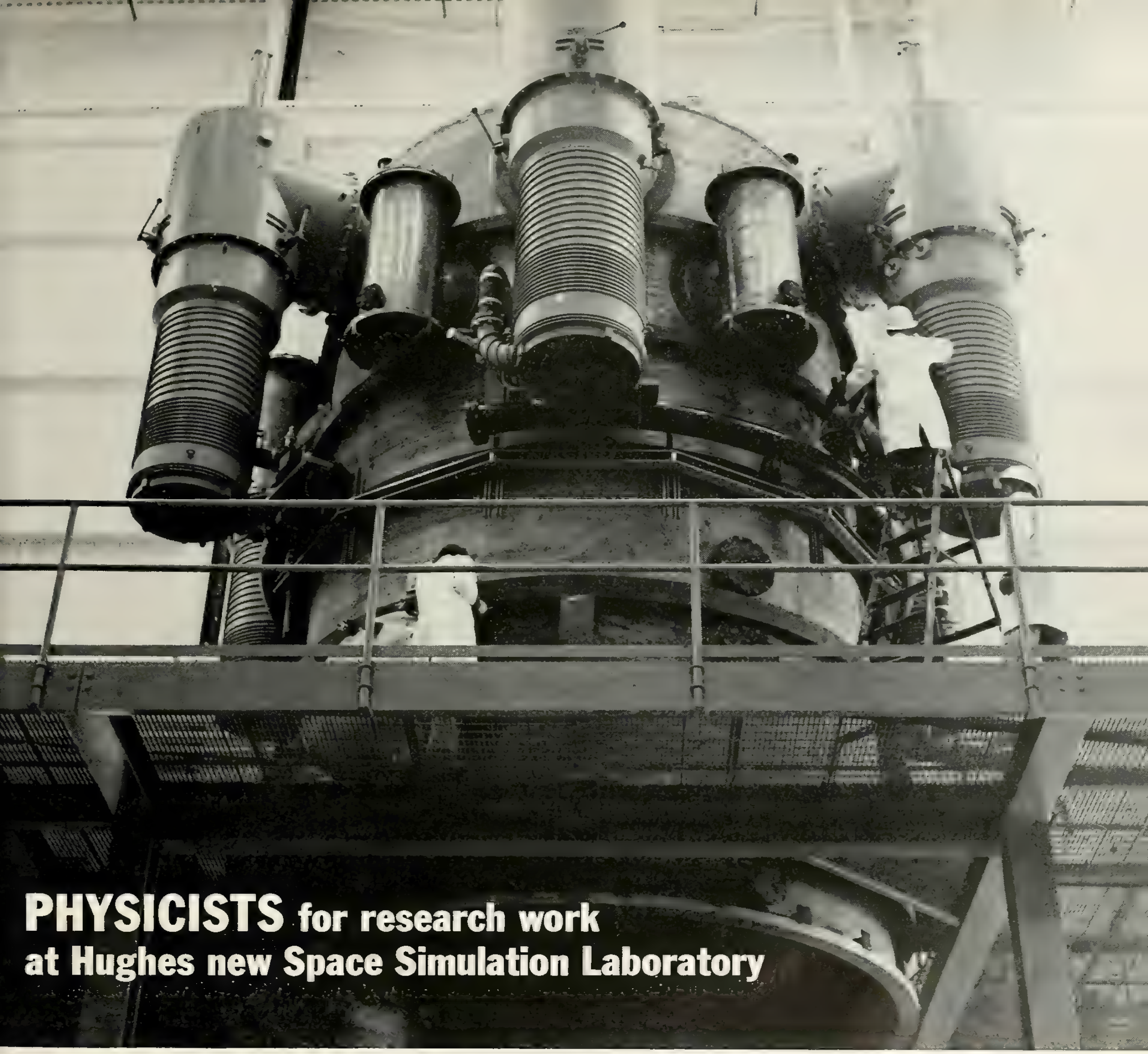
The point soon will be reached where it will be cheaper to test in space itself than to attempt to simulate the space environment here on Earth.

IT IS HERE that the need for a *Manned Orbital Development Station* for testing in space becomes evident—not only for testing spacecraft and components but in establishing standards for ground instrumentation.

In addition, there are certain types of testing which can only be done in space. Zero-g conditions and meteorite bombardment, for example, cannot be effectively or inexpensively simulated. Testing of nuclear power supplies and highly toxic fuels would be more practical in orbit.

The space station program should be initiated promptly. It could avert future disasters for multi-million-dollar boosters and spacecraft. That is the ultimate goal of test and checkout—to save money and to save lives.

William J. Coughlin



PHYSICISTS for research work at Hughes new Space Simulation Laboratory

Creating a near-perfect simulation of the space environment is an intriguing problem. There are more difficulties than appear on the surface.

For example, how would you achieve perfectly parallel rays of absolutely equal intensity to simulate solar energy? Or a far better vacuum than available presently? How would you theoretically forecast the behavior of various materials in a vacuum? What advances can be made to solve the problems of cryogenic pumping of very large vacuum chambers? To investigate these areas, Hughes Space Systems Division is organizing a small research group to support the efforts of the new Space Simulation Laboratory. Specific projects and programs being designed and developed are the SURVEYOR (Soft lunar landing vehicle); SYNCOM (Synchronous orbit communications satellite); several types of anti-missile missiles. Some of the key positions open now include:

Research Physicist. A doctor's degree in some related branch of physics would be strongly preferred. The position would involve major responsibility for the planning and direction and nature of the Space Environmental Laboratory's exploratory efforts. Also involved would be the direction of Experimental Physicists on planned programs and private investigations.

Experimental Physicists—Optics. The major responsibility would be to study and fully comprehend all the work in the field of solar simulation. The work would involve considerations of high temperature sources, geometric optics, evaluation of the optical parameters of materials, etc. Extremely long uninterrupted tests will be a vital part of the program to determine the reliability and operational characteristics commensurate with the Space Systems Division requirements.

Vacuum Technology. Order of magnitude improvements in the achievement of ultra levels of vacuum under conditions of high mass flow.

Cryogenics. Studies would include the use of cryogenic fluids for thermal control of space chambers, the development of techniques for fabrication of large cryogenic thermal panels and the investigation of surface properties at cryogenic temperatures. Ph.D. with experience in cryogenics preferred.

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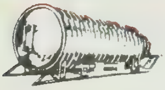

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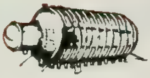

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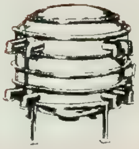

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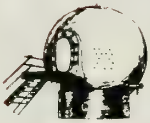

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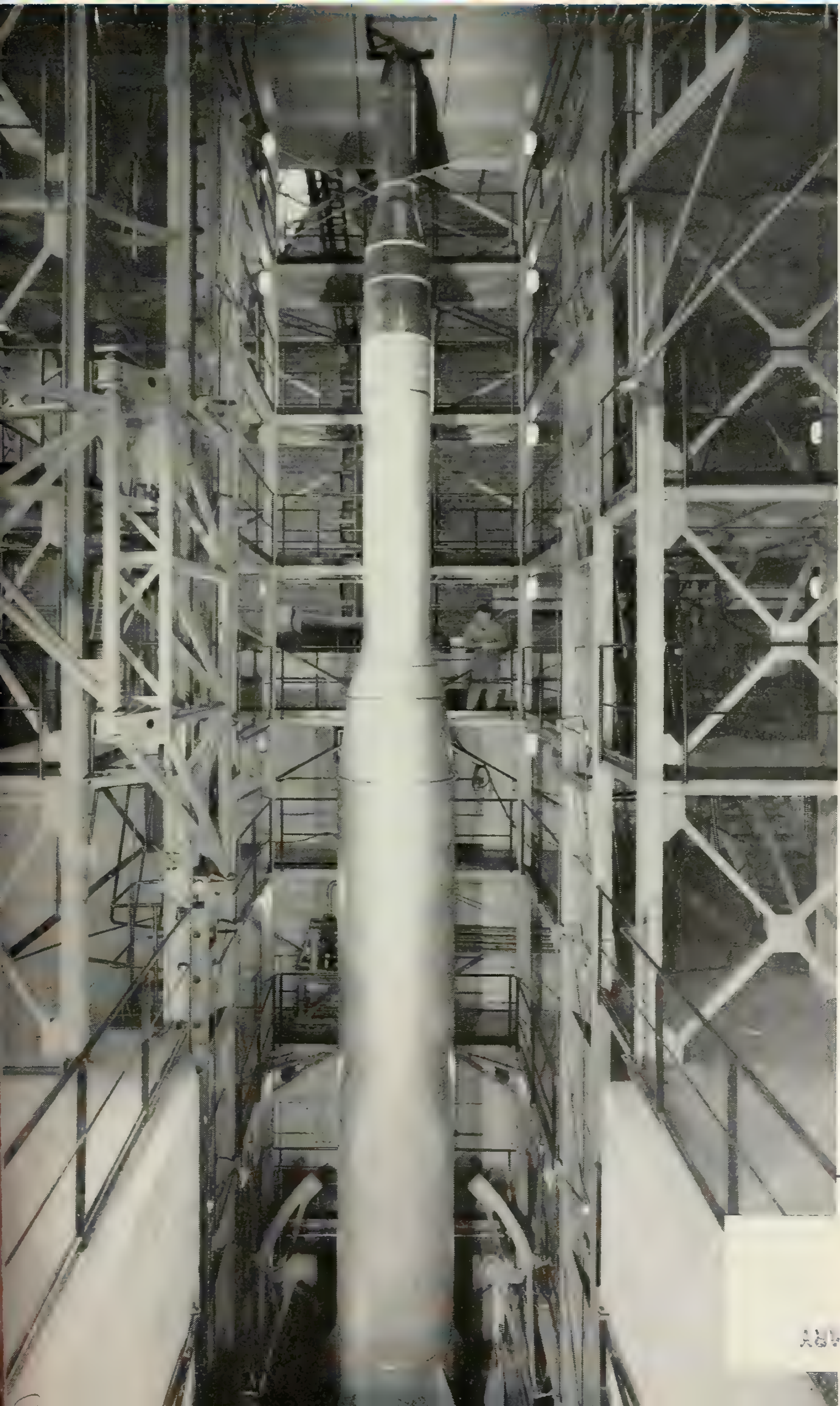

Report From 3rd European Spaceflight Symposium

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- **Decision on MA-10 Pending**
- **Exclusive— France's Diamant**

First Photo of France's Diamant

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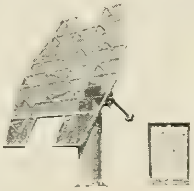

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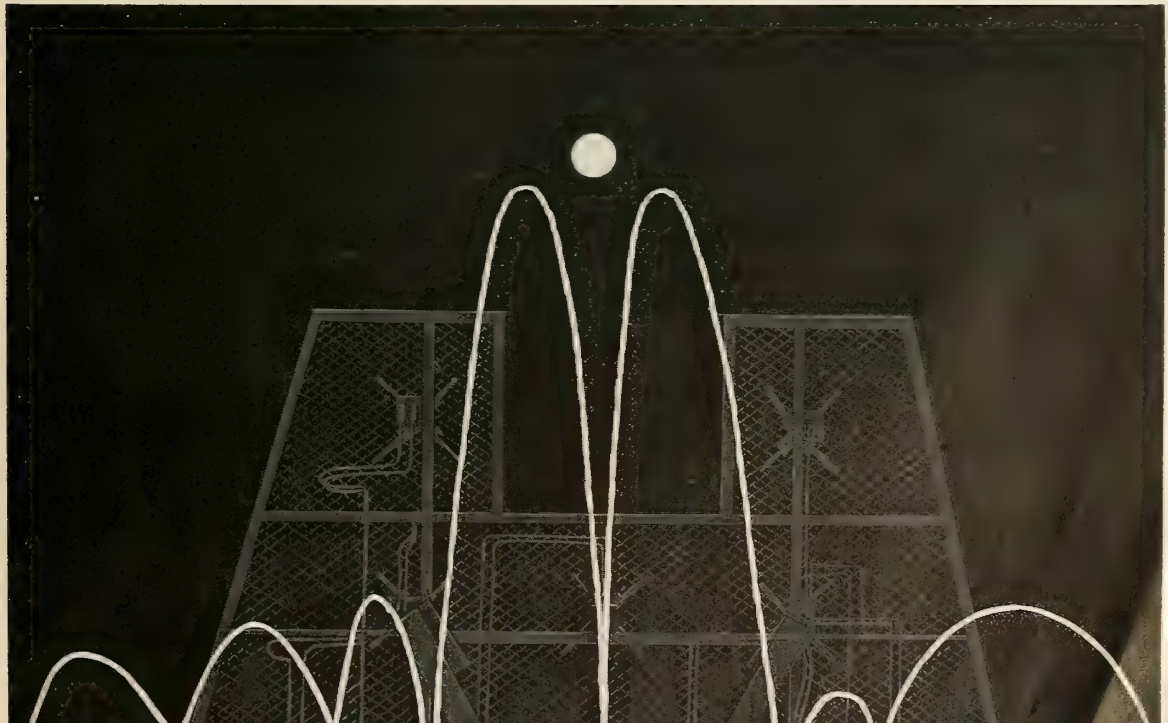

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At strategic military locations, thousands of orders for private lines and other services were met. Hundreds of telephones and teletypewriters were installed. Dial systems were set up. To get all of this done, engineers produced designs and specifications on the spot. Western Electric, manufacturing and supply unit of the Bell System, chartered nine planes to speed tons of equipment from 20 factory and warehouse locations.

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First photograph of French Diamant space rocket, 66-ft. version of which will be displayed during Paris Air Show. France may speed up its space research program. See exclusive report on p. 21.

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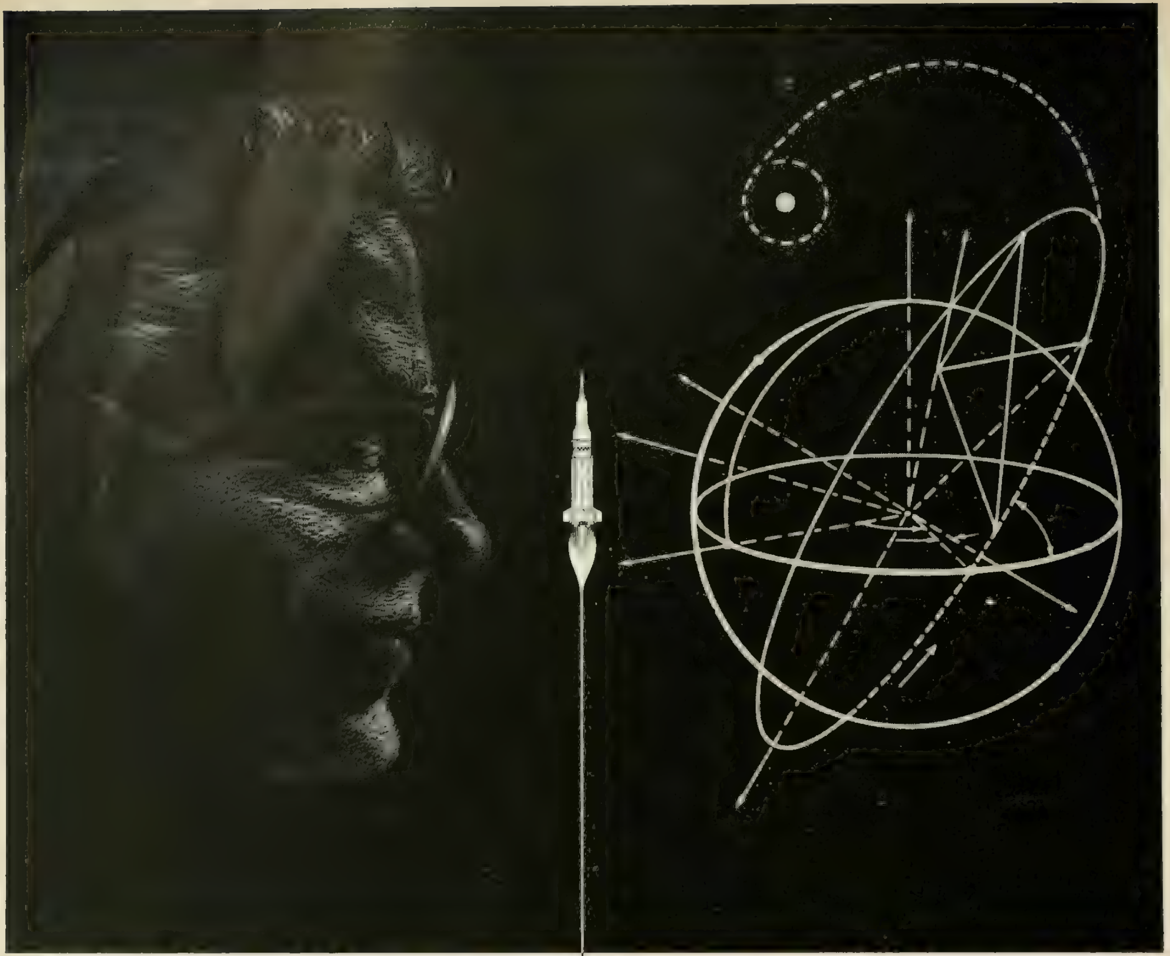

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letters

Doubts About Apollo

To the Editor:

Your May 13 editorial started off as a generous tribute to Dr. Theodore von Karman. Why did it have to deteriorate into a presumptuous and illogical indictment of the *Apollo* critics?

You say "... with scientists taking public stands on public issues far beyond their own realm, it is perhaps well to remember the gap between the scientist and the hard-headed practical engineer ... 25 of America's 55 living Nobel Prize winners took it upon themselves to criticize the present direction of Project *Apollo*. This dissent from the scientific community should not be taken seriously because it is not within the competence of the Nobel group ... to determine how much the U.S. should spend on its lunar program."

Surely anyone is qualified to judge the value of a publicity stunt (one aspect of *Apollo's* purpose), and who but a scientist is qualified to judge it as a scientific venture (its other purpose)? The prime purpose of engineers is to take the findings of science and translate them into something of use to humanity. A really "hard-headed practical" engineer cannot in conscience endorse a project with such a poor ratio of utility to expenditure.

All human endeavors are marked by periods of rapid advance followed by periods of consolidation. If a general omits to consolidate a spearhead, he loses his gains, his battle, and maybe his war. In civilian endeavors the loss is usually a financial one. History is studded with examples of the distastrous effects of over-extension, both military and economic. Project *Apollo* can be viewed as an over-extension. We have taken a good grip on orbital space. It would appear that this grip should be consolidated before the next spearhead advance is undertaken. At this point in time, even an orbital flight is an event that cannot tolerate an error; we have no way to rescue an astronaut from orbit if something should go wrong. To meet its goals, Project *Apollo* depends on the perfect execution of techniques (rendezvous, vertical landing, cockpit countdown, etc.) which probably will not be tried for the first time before mid-1965. How many attempts to conquer Mt. Everest failed because the dash to the top was tried before the necessary technology was adequately available? With the proper equipment and knowledge, three groups have successfully accomplished it in recent history.

Your rather unflattering criticism of Linus Pauling appears to lack the lucidity appropriate to such a patronizing attitude. Judging from your quotation from his comments, he speaks the truth. It appears quite obvious that far more worth would result from the exploitation of basic scientific research in many other fields. This fact is not altered by your statement regarding the distribution of funding. Surely waste can be judged on its own "merits." The fact that a given sum of money cannot conveniently be diverted into a more worthwhile endeavor is poor justification for tipping it down a rat-hole. There are plenty of good arguments for diverting some of the $30 billion for *Apollo* into other manned space projects. Project *Apollo* by 1970 could well be a very expensive and embarrassing failure. Project *Apollo* in the 1980-90 period could well be a logical extension of space technology. Proper consolidation of our present "spearhead" points to the extension of manned orbital capability through the development of space stations with their obvious scientific and military purposes.

You state that *Apollo* is regarded as essential and is so funded. This point any American citizen is entitled to question, and any one of the Nobel Prize winners is just as qualified to pass judgment on it as you are. The main reason it is regarded as essential is that the present occupant of the White House has publicly stated it as a National Goal; what, incidentally, is his competence in the scientific or engineering field? It is perhaps well to remember that the evidence of the last election shows his views to be supported by half the American population at best. He and his judgments may well leave the limelight in 1964, but the American people will still have the problem of determining their destiny. Some of them are obviously somewhat concerned about it now.

An analogy has been drawn on various occasions between Project *Apollo* and Columbus; perhaps this should be corrected by substituting Lief Ericsson, who apparently arrived at his ambitious goal too soon with too little.

Kenneth G. Hagen, Engineer
(hard-headed practical)
Paoli, Pa.

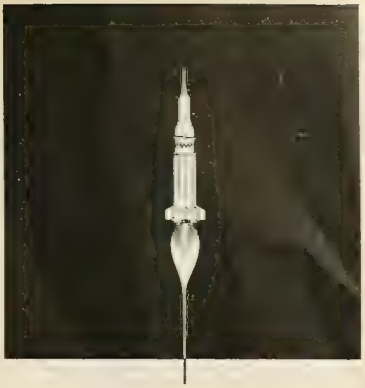
Early Cometary Proposal

To the Editor:

I enjoyed very much reading the article entitled "Scientists Plan Missions to Comets" in your May 6 issue (p. 22). I was particularly interested in the concept of orbiting a mass of frozen gas such as ammonia and CO_2 in order to get an observable artificial cometary head near at hand for detailed study.

At the Free Radical Symposium in Washington, D.C., sponsored by the Bureau of Standards about 1960, I made exactly this suggestion from the floor after the delivery of a paper discussing the free radicals observable in comet tails. At the time, there was little apparent reaction to my suggestion from the scientists attending the symposium. However, it pleases me very much that astronomer Swings is thinking and proposing along the same lines.

E. R. Bertozzi
Assistant Technical Director
Thiokol Chemical Corp.
Chemical Operations
Trenton, N.J.



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ELECTRICAL and ELECTRONICS

Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES

Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

MANUFACTURING

Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

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Supervise and maintain reference of standards in mechanical systems, electrical systems, quality assurance and systems automation; evaluate instructions and test procedures and develop techniques for adapting digital computers for automatic checkout systems.

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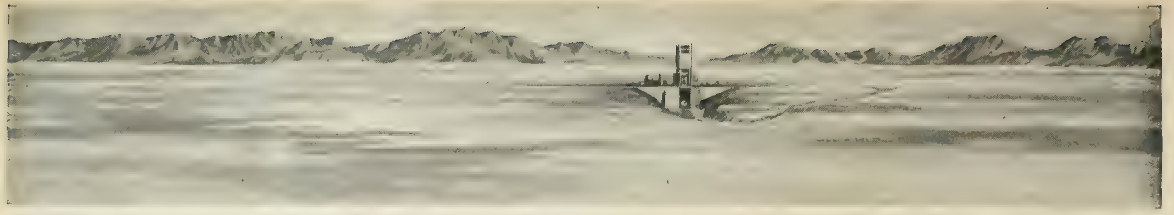

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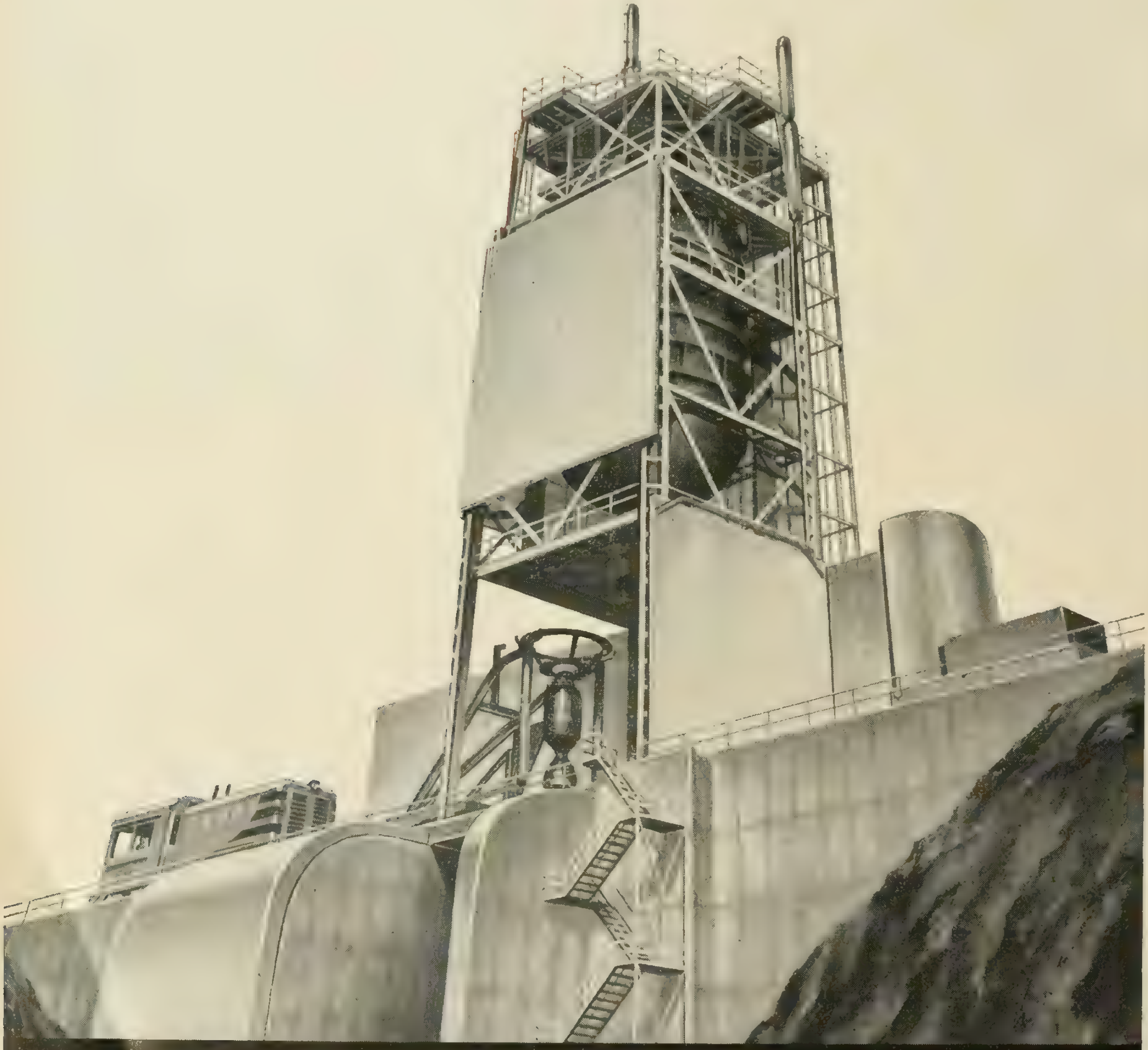


ARCHITECTURE · ENGINEERING · INSTRUMENTATION · FABRICATION · CONSTRUCTION MANAGEMENT

The Countdown

WASHINGTON

Last-Minute Lobbying Fails

Reason for the long delay in announcing contract awards in the large solid booster program (M/R, April 22, p. 14) is reported to have been a frantic last-minute effort on the part of one of the bidders to reverse the decision. Public announcement was about two weeks overdue after the official press release had been prepared by the Air Force, and the final release was considerably rewritten. More than the usual degree of bitterness is expected to linger on in the wake of the delayed announcement.

Florida Guards Tideland Rights

The Florida state government has rejected an Air Force request for off-shore rights on a stretch of Atlantic coast more than 100 miles long, extending from 10 miles north of Daytona Beach to 20 miles south of Melbourne. The Air Force did not say why it wanted the rights, but the arrangement might have permitted construction of future off-shore launch sites—as well as preventing off-shore drilling by minerals firms.

Atlas Proposed as Satellite

NASA's Office of Manned Space Flight has proposed to top officials that an *Atlas* booster be used as a micrometeoroid satellite. Plan calls for putting an instrumented *Atlas* into Earth orbit, utilizing the large skin surface to record meteorite impact. Final approval of the proposal depends on the *MA-10* decision (see p. 16). If that flight is not made, one of the *Atlases* left over from Project *Mercury* would be used for the satellite shot.

Inter-Agency Argument Snarls Tiros

A sharp disagreement between NASA and the Commerce Dept.'s Weather Bureau has forced a stop-work order which is halting RCA development of three operational *Tiros* satellites. The squabble involves design specifications submitted by the Weather Bureau. Main result will be delay in the launching schedule and higher costs.

Scout Gets More Muscle

NASA is uprating the *Scout* booster's second stage to give it a payload capability of 300 lbs. This compares with the original booster capability of 150 lbs. and a current 250-lb. payload in low Earth orbit.

Early Planetary Flight Planning

More than 150 NASA representatives attended a three-day meeting on future manned interplanetary missions at the Lewis Research Center last week. Subjects discussed included spacecraft design and construction, propulsion systems, and life support requirements.

POGO To Use UV Spectrometer

NASA has decided to include an extreme ultraviolet scanning spectrometer in its *POGO S-50* polar-orbiting geophysical satellite slated for launch next year. The spectrometer will be built by Dr. Hans H. Hinteregger of Air Force's Cambridge Research Laboratory.

INDUSTRY

OSO Award Drawing Near

Contract for development of NASA's *Advanced Orbiting Solar Observatory* is expected to be signed in the next couple of weeks. Three firms—Republic Aviation, Space Technology Laboratories, and Ball Brothers—are competing for the award.

RCA on Track for LEM Radar Job

RCA is expected to share in at least part of the subcontract for the *Apollo* Lunar Excursion Module's radar system. Grumman is to announce the award about June 1. System would be used to achieve rendezvous with the orbiting Command and Service modules.

Navy Wants Backup for FBM Fuel

Recent explosion in the West Virginia facility which supplies the *Polaris* fleet ballistic missile program with high-energy nitroglycerine-based propellants is reported to have spurred Navy interest in finding a second source for the propellant. COUNTDOWN has been told that one of the strongest possibilities for filling the need is Lockheed Propulsion Co.'s nitroplastisol propellant, which is to be employed in the Navy's *Phoenix* missile for the TFX.

Alabama Firm Lowest on Saturn V Towers

Ingalls Iron Works of Birmingham, Ala., is low bidder for the development of three Launcher Umbilical Towers for the *Saturn V* booster complex at Cape Canaveral. Ten companies submitted bids, with Ingalls setting a pricetag of $11,225,368.85.

Wonder Where the Greenbacks Went?

The following wire, sent to contractors *after* they had proposed on a recent NASA RFQ for a crucial *Saturn* launch-complex system, is indicative of where a not-insignificant part of industry's money goes: "For Proposal Q-28-3, Digital Propellant Loading Control System, cancellation of. Subsequent to receipt of proposals and prior to any evaluation effort by the government, it was determined that the requirement covered by this solicitation was a duplication of an existing requirement within the scope of the NASA contract with the General Electric Company. Advise desired disposition of your proposal. . . . Launch Operations, Cocoa Beach, Florida."

INTERNATIONAL

Eight European Nations Can Deliver 'Nukes'

U.S. nuclear weapons can now be delivered by at least eight European countries, although ultimate control of the warheads still rests in American hands. However, these "target of opportunity" nuclear weapons are expected to be downgraded by U.S. strategists in favor of pre-targeted weapons operating under a multinational NATO nuclear force.

NAA Showing Navigator at Paris

A new, lightweight inertial navigator designed for use in both aircraft and missiles will be introduced at the forthcoming Paris Air Show by Autonetics Division of North American Aviation.

Shillelagh Nearly Operational

The Army's director of special weapons, Brig. Gen. William T. Ryder, has disclosed that the Ford Aeronutronic *Shillelagh* antitank missile will soon be operational.

"We expect its kill probability to be quite high against the heaviest armor," Ryder told those attending the Aviation/Space Writers Assn. meeting in Dallas.

Ryder, who is in the Army's Office of the Chief of Research & Development, described the *TOW* antitank missile as "not so far along," and confirmed that it is a wire-guided weapon—a somewhat simpler system than *Shillelagh*.

Ryder also said the Army now has a program under way to give *Nike-Hercules* a capability against tactical ballistic missiles as well as aircraft. He said this will be done by providing more sophisticated circuitry and computers.

The Army official described AADS-70 as a weapon system to cope with both aircraft and tactical ballistic missiles in the 1970's.

Gemini Tests Successful

The first series of drop tests to qualify the parachute recovery system for the two-man *Gemini* spacecraft has ended successfully at El Centro, Calif. the manned Spacecraft Center announced recently.

The parachute recovery system, designed by Northrop's Ventura Div., will be *Gemini's* primary water landing system. The parachute system is designed for wet landings and will be used for unmanned and early manned *Gemini* flights.

The system consists of an 18-ft.-dia. ring-sail drogue and an 84-ft.-dia. ring-sail recovery parachute packed in a rendezvous-and-recovery section mounted on the small end of the spacecraft. The canister also houses the *Gemini* rendezvous radar equipment.

The recent series consisted of 20 development drops of the main and drogue parachutes. These tests checked out the deployment characteristics and the structural integrity of the individual chutes.

The qualification tests, scheduled for completion in early 1964, will test operation of the recovery system. This will include the parachutes, the pyrotechnic devices that explosively trigger the deployment and release of the parachutes and the timing system—technically called "sequencing," which triggers the various events at the proper time.

Twenty tests are scheduled using a *Gemini* boilerplate, a dynamic duplication of the *Gemini* spacecraft in configuration, weight, weight distribution (center of gravity) and "response" through its size and weight. Two additional tests using "static articles," a structural duplication of the *Gemini* spacecraft not only in size and weight, but in materials and construction, will finalize testing of the recovery system.

Shots of the Week

The Soviet Union on May 22 launched the 17th unmanned space satellite in a series thought to be in preparation for a new space attempt, possibly by a woman. The Russian news agency Tass reported the *Cosmos 17*-borne instruments functioned "normally" and were transmitting data to Earth by radio. The *Cosmos* was said to be circling Earth once every 94.82 minutes with perigee and apogee of 161 and 488 miles respectively.

Other shots of the week:

- The Navy's *Polaris A3* completed a successful 1,800-mile flight down the Atlantic Missile Range from Cape Canaveral May 17. The two-stage missile sent an instrumented nose cone into the fringes of space and back to a target area in the Atlantic.
- An Air Force *Minuteman* ICBM launched May 18 from Cape Canaveral fell short of the intended range, but met most test objectives before impacting in the Atlantic.
- A NASA *Scout* rocket carried a dummy nuclear reactor 90 miles over Wallops Island, Va., May 22. The non-radioactive mockup was then plunged down through the atmosphere at 15,000 mph in a test to determine if frictional burning would render a radioactive version harmless.

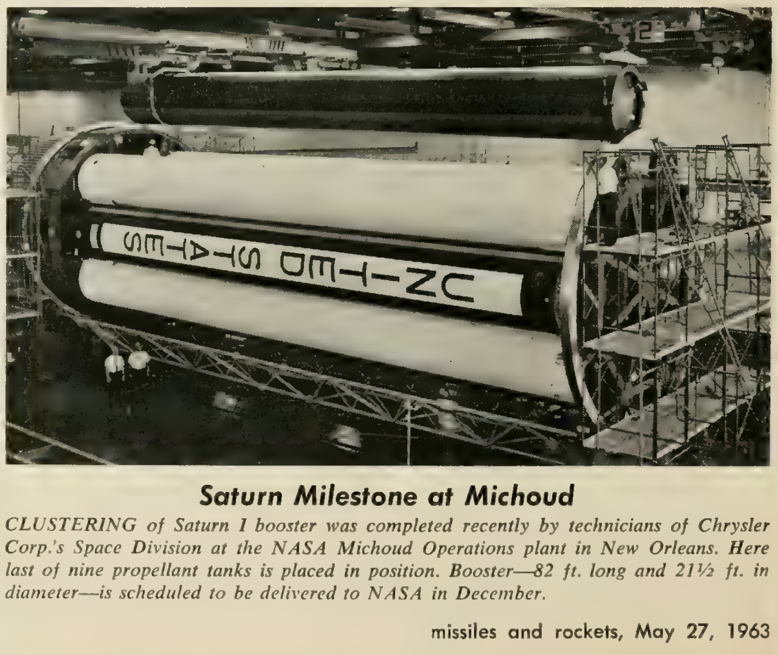
The test was in preparation for an orbital trip of a Space Nuclear Auxiliary Power (SNAP) atomic power plant planned by the Air Force next year.

- A *Blue Scout* probe was conducted by the Air Force May 17 from Pt. Arguello, Calif. No further information was given.

IAM, Boeing Reach Accord

Approval May 15 of a three-year contract between the International Assn. of Machinists and the Boeing Co. has finally dissolved a strike threat that had been simmering for months.

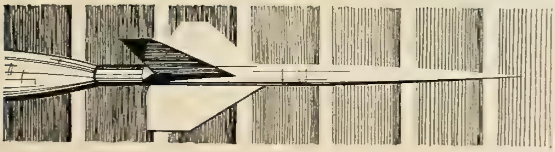
IAM members overwhelmingly endorsed the modified agreement, chief issue of which was the performance



Saturn Milestone at Michoud

CLUSTERING of Saturn 1 booster was completed recently by technicians of Chrysler Corp.'s Space Division at the NASA Michoud Operations plant in New Orleans. Here last of nine propellant tanks is placed in position. Booster—82 ft. long and 21½ ft. in diameter—is scheduled to be delivered to NASA in December.

Scientists and Engineers, too, Look to Lockheed for Leadership



PAPERWORK GETS THE AIR

THEORETICAL CALCULATIONS TAKE YOU ONLY SO FAR. Comes a time when paperwork gets the air in high-velocity wind tunnel tests. In these tests, air at Mach 3-plus speeds slam against the scale models of various wing-body configurations. Result: a formula is converted into form; mathematics into contoured metal.

At Lockheed-California Company, a team of engineers and scientists currently is engaged in an intensive study of flight and operational characteristics involving America's first Supersonic Commercial Air Transport (SCAT). These studies include evaluation of flight and wind tunnel data to determine performance criteria and mission capabilities of tomorrow's airliner.

Planned to operate on the fringes of space, SCAT presents many unique problems. The solutions are doubly important, since they involve factors of practical application to airline operation. Advanced conceptual studies are also being carried on with V/STOL aircraft, hypersonic fighter aircraft and rigid-rotor helicopters.

Projects such as these at Lockheed-California add up to an exciting future—make it yours!

QUALIFIED SCIENTISTS AND ENGINEERS are invited to investigate immediate openings in: Aerodynamics; Thermodynamics; Dynamics; Astrodynamics; Structural Dynamics; Propulsion; Operations Research (Weapons systems evaluation or cost effectiveness); Human Factors; Reliability; Spacecraft Propulsion (Missiles and Space Vehicles); Controls and Guidance.

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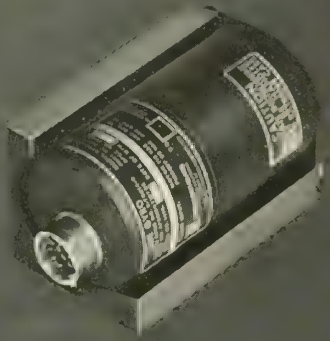

American Gyro's miniature rate gyros have achieved a reliability in excess of 35,000 hours aboard Northrop's USAF T-38 supersonic twin-jet trainer. Used in the stability-augmentation system, the gyros must endure the severe environments of this very-high-performance aircraft.

The ability to perform reliably under severe environment is the hall mark of American Gyro products. That's one reason they were selected for such important programs as the F-102, F-106, A4D, Orbiting Astronomical Observatory, Apollo, Titan, Polaris, Discoverer, and Regulus.

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analysis policy of the company in which supervisors evaluate the employee's work. The vote was 14,205 in favor of the new agreement, 4,688 against.

The agreement also included a modified form of union security. The IAM had been seeking a union shop.

An IAM strike against Boeing, a major aerospace manufacturer, had been averted twice before. President Kennedy stepped in to get an 80-day cooling-off injunction Jan. 25.

When the injunction expired, the union called a strike for April 16. Boeing then revised its contract offer, giving some ground on the union shop issue, and the strike was called off.

NASA Buys 23 More Scouts

NASA has awarded a $10,687,500 contract to Chance Vought Corp., a division of Ling-Temco-Vought, Inc., for 23 *Scout* launch vehicles.

Scout—this country's only all-solid-propellant satellite launch vehicle—is a four-stage vehicle, 72 ft. long, 40 in. in diameter, and generates 95,000 lbs. of thrust in the first stage.

Scout is credited with being the first all-solid-fuel rocket to place a satellite in orbit with the successful launch of the *Explorer IX* satellite from Wallops Island Feb. 16, 1961. It was also used in several re-entry experiments and the successful orbit of the *Explorer XVI* micrometeroid satellite from Wallops last Dec. 16.

The vehicle can now place a 250-lb. payload into a 300-mi. circular orbit, compared with its initial capability of slightly more than 150 lbs. three years ago.

Bullpup B in Production

Production of the *Bullpup B* air-to-ground missile will begin immediately at the Martin Co.'s Orlando, Fla., division. The Bureau of Naval Weapons awarded $3,389,501 for production May 22.

In making the announcement, the Navy emphasized that the larger *"B"* version will not replace the original *Bullpup*, which has been operational on Navy, Marine and Air Force fighters for four years. Martin is prime contractor for the *Bullpup* program.

Introduction of *Bullpup B* gives the Navy air arm the ability to engage a greater variety of land and sea targets, according to Martin.

Initial procurement of the *"B"*-version missiles is covered by a fifth-year contract for the basic *"A"* missile awarded Martin by the Navy more than a year ago.

Bullpup B is longer and heavier than the *A* model. To power its supersonic flight, the Navy has fitted it with a scaled-up version of the highly successful pre-packaged liquid motor developed for the original *Bullpup* by the Reaction Motors Div., Thiokol Chemical Corp.

Project Fire Launches Set

NASA's Project Fire, which will study heat loading encountered on re-entry from lunar and planetary flights, will get under way at Cape Canaveral with a launch late this year.

First of two currently scheduled flights has been set for the fourth quarter of 1963 and the second will come about six months later.

An *Atlas D* will be used to carry the Fire spacecraft to apogee. An *Antares* booster will drive it back into the atmosphere at hypersonic speeds.

The flights will result in the highest velocities yet achieved in real atmosphere with a large model, and should contribute significant information for application to manned spacecraft design.

The Fire spacecraft produced by Republic Aviation, is 26 in. in diameter and has the general configuration of a *Mercury* capsule. Its 185-lb. weight includes 75 lbs. of heat protection and an equal amount of electronics. The remaining 37 lbs. consists of structural members and cooling equipment.

General purpose of Project Fire is production of data concerning the environment or re-entry as it affects radiative and convective heating of the spacecraft.

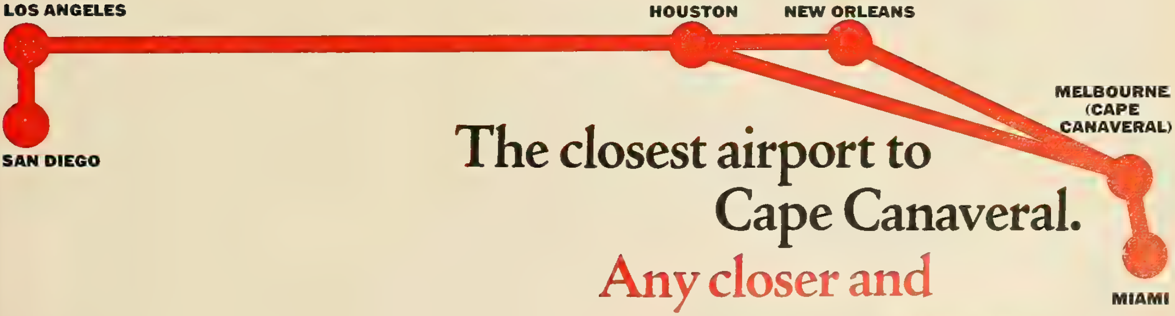
The spacecraft shell consists of three layers of beryllium separated by a phenolic-asbestos material. Thermocouples are placed at various depths and locations.

Temperature histories from each of these 48 points will be recorded against time to provide data on deterioration of the spacecraft shell from re-entry heat.

The *Atlas* will have a normal burn, and after separation the Antares and Fire spacecraft will coast to about 800 miles altitude.

At apogee, gas jets will re-orient the spacecraft-booster combination for the downward flight. The *Antares* burnout will occur before re-entering at approximately 25,000 mph.

Here's National Airlines' new thru-jet "Rocket-Run"



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LOS ANGELES	1:10PM	12:50PM
HOUSTON	5:40PM	5:10PM
MELBOURNE	9:00PM	8:35PM
MIAMI		9:37PM

WESTBOUND

	LEAVE	ARRIVE
MIAMI	1:35PM	
MELBOURNE	2:45PM	2:12PM
NEW ORLEANS	3:40PM	3:14PM
HOUSTON	5:00PM	4:32PM
LOS ANGELES	7:55PM	7:00PM
SAN DIEGO†		8:41PM

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3rd Spaceflight Symposium . . .

Cooperation Keynotes Meeting

ESRO, ELDO suggested as components in proposed NASA-like European Space Agency

by William Beller

STUTTGART, WEST GERMANY—The growing pains involved in building a multilateral spaceflight program were clearly evident during the third European Spaceflight Symposium.

Many of Europe's leading figures in astronautics attended the May 20-24 meetings organized by the three largest European societies for advancement of spaceflight—the British Interplanetary Society, the French Astronautics Society and the German Society for Rocket Technology and Spaceflight.

The European space community realizes it must cooperate on major programs because of the high cost of space vehicles. This point was brought out strongly by L. R. Shepherd, BIS president, who said "such collaboration will give us our only chance to do the work in a serious manner."

The speaker suggested that the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO) be two components in an organization called the European Space Agency. This would be a NASA-type agency whose projects would include the ELDO launch vehicle as well as later high-energy ballistic vehicles. Other projects recommended by the Briton included a recoverable air-breathing booster, advanced propulsion systems and manned flight.

- **Cooperation, but . . .**—Shepherd's view was echoed in part by Georges Fleury, FAS president, who said "cooperation of European governments as well as industry will permit us to do together what we cannot do alone." But Fleury left the door open for separate spaceflight work by his country. It has already been announced for instance that France will build a civilian launching range on the Mediterranean coastline. From here the first all-French satellite is expected to be launched by *Diamant* rocket (see p. 21) in 1965. The base probably will be offered for ESRO-ELDO use.

Despite the drive for cooperation in space, individual countries still want to retain some of their retailing privileges. In this regard Hans Lenz, newly appointed German Federal Minister for scientific research told MISSILES AND ROCKETS he will be in the United States at the end of this month to try to persuade NASA to cooperate with the German Republic on space research and launch vehicles. Albrecht Weber, the Minister's aide, said France and Italy are already getting such help.

Weber volunteered that NASA is a far more difficult agency to deal with than the Atomic Energy Commission, with which the Federal Republic has a number of agreements. "NASA wants a fifty-fifty deal," he said, "not only on a cost-sharing basis but also in terms of manpower, data-reducing and exchange of scientific and technical information." He added that Germany can understand this viewpoint but that the preferable agreement would be patterned after the AEC's, wherein the American agency underwrites about 75% of the burden and Germany the rest.

Lenz told the symposium "it is vital that small and medium-sized countries allocate substantial parts of their budgets for international space R&D." Only in this way can each country keep up with space technology and realize its benefits, he said.

- **German plans**—The work of Lenz's ministry will be limited to advising the Federal Republic about research directions and laying out guidelines for German industry in the fields of aeronautics, atomic energy and space. In this regard, Lenz said, "we will limit our advice to industry to the irreducible minimum." He added that private industry must have full scope to develop under its own initiative.

Lenz also brought up the high cost of spaceflight, remarking that "we must limit ourselves to the areas where we can make definite contributions and leave to others to do what they are better able to do." He stated, however, that Germany wants to promote scientific and space research from public funds for 1964. Lenz's ministry has asked for a considerable budget increase for such purposes. "Approval of this increase," said Lenz, "will depend on how well we use the 1964 money."

He strongly emphasized that money for scientific education and basic research should have the same priority as funds for space technology. The 1963 Federal Republic space budget, although relatively small, jumped by a factor of three over the nation's 1962 budget. In 1963, the total was $24.2 million; in 1962, $8.7 million.

Germany contributes 22% of ESRO-ELDO funding. The ESRO program is budgeted at $300 million over an eight-year period; ELDO at $200 million for a five-year period.

The German national space program—expected to cost upward of $25 million over the next two or three years—will undertake studies and work in five major areas, said Lenz. These are (1) recoverable high-altitude research rockets; (2) high-energy propulsion systems such as a hydrogen-fluorine third stage for the ELDO rocket; (3) space transportation vehicles; (4) research satellites with ELDO or U.S. launchers; (5) space chambers and test facilities for space research.

Asked whether Germany would consider cooperating with the U.S. Communications Satellite Corporation in helping to provide a European link, Lenz told M/R he would look favorably upon such a venture.

- **Motivations**—Many reasons are given for European countries undertaking space programs, and they vary widely according to their sources. Shepherd pegs the reason squarely on future economic returns. He observes that because of "undue" concentration on *Apollo* there are gaps in the U.S. program that it would make good business sense for Europe to fill. Developing a fully recoverable booster is one example he gave of a goal that is not a prime target of the U.S.—nor possibly of the Soviet—and yet is one that is economically viable for Europe. "We can compete here," he said, "or collaborate."

On the other hand, Eugen Saenger, professor of astronautics at the Technical University of Berlin, said a European space program is necessary in order to maintain the competitive standing of European industry. Saenger did agree with Shepherd, however, that Europe does not want simply to repeat what is being done in the U.S., but rather wants to do whatever else is needed.

One seasoned observer of the European space scene gave this generalized appraisal: Britain wants spaceflight for commercial purposes, France for national prestige, and Italy for the personal glory of its participants. Germany is as yet undecided.

Although at a press conference a panel of outstanding European space scientists vehemently denied that their nations were going into space research for prestige reasons, later conversations indicated that this factor—plus the fear of becoming a second-rate community as the Space Age advances—are the overriding factors pushing Europe into cooperative space ventures.

Continuing his thesis that spaceflight should have an economic payoff, Shepherd decried a short-term view looking only to space research and communications satellites. If this were the case, he said, "it might well be better to buy American vehicles for the former and rely on the American communications network."

Admitting that the U.S. or Russia will be first to land men on the Moon, Shepherd maintained that this is only the first step—like Columbus setting foot on America. Europe will be concerned with "events that must occupy many decades of development after the initial landings," he said.

- **Proceed by stages**—Shepherd places large expendable liquid-propellant rockets in the same evolutionary class as Neanderthal Man. For this reason, he sees no reason to build a booster bigger that the *Blue Streak*. The emphasis, he said, should be put on developing boosters that are simply and easily recoverable and can be used repeatedly. "The only satisfactory type of booster for this purpose would be one employing air-breathing engines," he said.

Shepherd recognized that although such advanced launch vehicles might be a fertile development for the European community, there is an initial learning process that must be gone through. The ELDO launch vehicle, for instance, "is already an obsolete vehicle," he affirmed, yet it is a necessary training tool to develop European space technology.

Even here there might be an opportunity for advanced work in the third stage. Eight ELDO vehicles are to be built; the first one is expected in 1966. The first stage is Britain's *Blue Streak* and the second stage is derived from the French *Véronique*. The third stage will be built by a German combine called the Development Ring North—comprising Boelkow-Entwicklungen and three other companies located in Bremen and Hamburg. The satellite will be built in Italy.

Dietrich Koelle, Boelkow project engineer on the third stage, revealed at the symposium that a high-energy third stage now under development uses a pressurized propellant combination of hydrogen and liquid oxygen, and a further study contemplates using liquid fluorine instead of oxygen. The results of the studies indicate, he claimed, that the payload capacity of the ELDO launch vehicle can be increased through use of fluorine "from approximately 100 kilograms to some 700 kilograms for escape missions."

The feeling throughout the symposium was that European space scientists would like to build on American and Soviet space technology and at the same time make proportional contributions. This was summed up by Shepherd, who proposed that "the construction of a major orbital station might be taken as the first significant exercise in international cooperation in space." ■

Air Force May Be Put in MODS Driver's Seat

DALLAS—Possibility that the Air Force, rather than NASA, will manage the joint DOD/NASA effort to place a *Manned Orbital Development Station* (*MODS*) in space has been strongly indicated by a top Pentagon spokesman.

Dr. Lawrence L. Kavanau told the Aviation/Space Writers Assn. meeting here that the Department of Defense was not able to make any contribution to the design of *Gemini* because of the late point at which the joint DOD/NASA agreement was signed. He warned that the Defense Department, acting through the Air Force, expects to be a full partner in the *MODS* program—possibly even managing it. He said he will recommend Air Force management.

Kavanau, special assistant for space to the Director of Defense Research and Engineering, further indicated that the role of each agency in the major undertaking would require Presidential approval. He postulated that a near-Earth orbital station may have more importance for military operations than for NASA programs.

- **Word of caution**—He warned, however, that "military mission capabilities in space will not *ipso facto* evolve merely because we are able to attain an experimental capability in the medium." He reiterated the DOD argument that military missions in space are still too vague to justify embarking on a full-scale program.

"I wonder if anyone here has any realistic assessment of the number of man-hours which have been devoted to this task of defining and re-defining useful military missions in space. The number must be staggering. Large groups, extremely capable groups, military groups, scientific groups, industrial groups, all have contributed. . . . Additional attempts are still under way. . . . Some definitions evolved to date are good. Others have been quite vague and based almost wholly on intuition. Those missions which have been defined were identified at the very outset of the Space Age," he declared.

Turning the coin, he pointed out the multi-faceted nature of national defense against a wide variety of potential threats. "Whether we like it or not, we are doing many things because our opponents in today's global struggle force us to do them."

Pointing up the costs involved, Kavanau added that all military space efforts will be extremely expensive, with the development costs turning out to be minor compared with the construction and operation of such a base.

"Military need, by definition, requires the capacity to conduct reliable repetitive space operations. The technology for operations is increasingly distinct from the technology for experimentation. One, or even a few, satellites which work long enough to yield data or conduct small-scale transient operations may be interesting, necessary and even useful," he point out, "but satellites for continuing military use will generally be totally different."

- **Opportunity demanded?**—Harking back to several historical precedents of technological developments that were available years before their most valuable applications were discovered, Kavanau said:

"History strongly suggests that opportunities must be provided for the military use of space to mature even though the presently conceived military space missions are not all persuasive ones. . . . Some men have the imagination to predict quite different uses for new technologies, but their voices are always heard along with a lot of contradictory advice, and often they are ignored. It is very difficult to pick the correct signal out of the noise—especially if you happen to be tuned to the wrong frequency."

Astronauts, Top NASA Leadership Split Over Attempting MA-10 Shot

Webb, Seamans indicate supporters of another Mercury flight face an uphill struggle; decision may be delayed

A DECISION on one more manned space flight in the *Mercury* series will not be made by a badly split space agency until late this week at the earliest.

The go-or-no-go for the *MA-10* flight may be delayed even longer awaiting the analysis of complete data from Astronaut L. Gordon Cooper's successful 22-orbit *MA-9* flight on May 15-16. Furthermore, top NASA officials have decided to give a full hearing to supporters of the additional flight before making a final judgment.

NASA Administrator James E. Webb and Associate Administrator Dr. Robert C. Seamans, Jr., have both indicated that *MA-10* supporters face an uphill battle.

Webb said the flight would be made only if there is some unexpected gap in manned space flight information. Seamans declared "it is unlikely that we will have an additional *Mercury* flight."

Arrayed against the top NASA management are the seven *Mercury* astronauts, the *Mercury* program's flight operational team, and officials of the Manned Spacecraft Center.

- **White House hands-off**—The debate intensified last week as the astronauts took their case to President Kennedy. He said that while the astronauts felt an additional flight would be "worthwhile and useful," the decision will be made by NASA and "I will not intervene."

The seven *Mercury* pilots were also scheduled to present their case to NASA's top management on May 23 and 24. Other meetings to discuss the flight will be held this week, according to a NASA spokesman.

One of the major problems facing approval of the flight is the lack of any request for *Mercury* program funds in the Fiscal 1964 budget now being considered by Congress. In order to make the flight, the space agency would have to submit a request to Congress for a supplementary authorization.

This could run into difficulty in a Congress which has already heard many calls for reduction in NASA's $5.7-billion budget.

Rep. Olin Teague (D-Tex.), chairman of the Manned Space Flight Subcommittee, told MISSILES AND ROCKETS "I personally believe that NASA should make the *MA-10* flight." He said, however, that he did not know the opinions of other members of the important space committee.

If NASA decides to go ahead with the mission, activities already under way could permit the agency to make a launch as early as the first week in September.

- **MA-10 readied**—McDonnell and Mercury technicians have been busy for the past three months modifying a *Mercury* spacecraft to permit a flight of at least 72 hours.

Most of the work, which is being done in Hangar "S" at Cape Canaveral, has already been completed. If the *MA-10* flight is approved, minor modifications dictated by the Cooper flight will be worked into the spacecraft.

The present timetable calls for spacecraft testing in the Hangar "S" high-altitude chamber in mid-June and completion of hangar testing by mid-July. This would permit mating the *Mercury* capsule and the *Atlas* booster in time for a September flight.

Most of the modifications deal with enlarging the capacity of fuel and life support facilities to permit the three-day flight.

Cooper reported at his post-flight press conference he had "several days of oxygen left" and that he used only about half the fuel carried for the altitude control system.

Chris Kraft, chief of flight operations for Project *Mercury*, said in a post-touchdown conference the spacecraft had enough oxygen left to make the mission total six days.

Kraft also said the flight path achieved by *MA-9* would have lasted for at least 92 orbits. He added that the *Mercury* spacecraft can easily be reworked to stay up that long without extensive removal of equipment.

"Offhand, I would say there is a lot to be gained from another flight but we must analyze what happened on *MA-9*," Kraft added.

- **Malfunctions**—Kraft said the greatest concern in *Mercury* control came when Cooper lost his 250-volt primary inverter at 31 hours and 20 minutes. An attempt to start the standby inverter was unsuccessful.

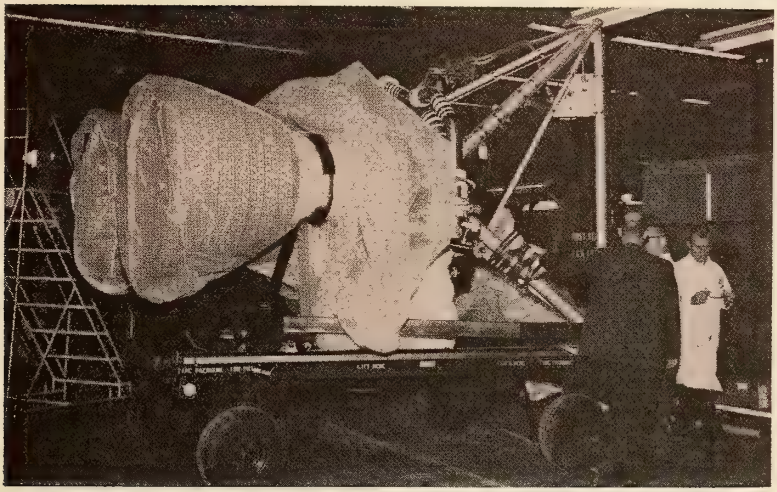
Cooper reported that the inverters, which had overheated on the *MA-5* flight, ran at relatively low temperatures throughout the flight. When signal lights indicated the standby inverter was on, though actually it was not working, Cooper learned that his primary inverter voltage was fluctuating widely. He decided to stop the machine. He then learned he could not start the standby inverter.

"I did not really trust these gauges too strongly," he said.

Cooper was forced to resort to re-entry without use of the auto pilot because a malfunction during the 19th orbit caused the auto pilot to skip the sequences which would have included positioning for retrofire and the retrofire command.

By skipping over both these, the sequencer had locked in the re-entry mode and could not be recycled to in-

WHALEBOAT from carrier Kearsarge tows Faith 7 capsule toward ship after near-perfect manually controlled landing completing MA-9 trip.



FOLLOW-ON Gemini program moved ahead on one front recently when Aerojet Titan II first-stage engine was flown to Martin-Baltimore.

clude these two critical steps.

Cooper flew by wire and aligned the spacecraft for re-entry by using the horizon and stars for reference in controlling pitch and yaw. The retrofire was done on a voice count from astronaut John Glenn, who was on the Coastal Sentry Quebec command ship standing off the coast of Japan. The manual proportional system was used on retrofire.

Kraft said in his conference he felt the Automatic Stabilization and Control System should be retained as a supplement to the manual controls in future manned spacecraft.

- **Experiments**—During the flight, Cooper probably took more pictures than any other astronaut. He said he used a Hasselblad camera with 70 and 80-mm lenses to take pictures whenever "he saw something interesting." He said he snapped some pictures over Red China during the last phases of the mission, but did not take any planned photos of specific objects.

Besides the picture-taking, Cooper also conducted more experiments than ever before in the *Mercury* program.

Perhaps the most important was the successful sighting of a flashing beacon, which Cooper predicted would enable astronauts orbiting in space to rendezvous at night.

During the third orbit of *MA-9,* a 5¾-in. capsule equipped with two flashing lights was ejected from the *Faith 7* spacecraft. This was the first launching of a satellite from a manned spacecraft.

Commenting on the ejection of the capsule by a spring device, the *MA-9* pilot said, "it really took off."

Cooper lost sight of the beacon immediately. Later as he came into the night portion of the fourth orbit, he said he observed "a light coming from below me on the ground."

At first, Cooper said, "I thought someone was launching something out in front of me."

"It was down below me against the Earth and gradually rose up, and as I watched it I finally saw that little rascal strobing and it was the flashing beacon."

Cooper also picked up the flashing light in his fifth revolution around the Earth. He estimated that he was able to spot it at distances up to 18 miles.

Cooper's ability to see the light apparently answers one question concerning rendezvous operations in space. That is what visual reference can be used to achieve the final docking maneuver between two orbiting spacecraft.

- **No physical problems**—Another important experiment was the medical checks made on the astronaut. Cooper said he survived his 34 hours of weightlessness with absolutely no lasting adverse effects. The only trouble, he said, was a momentary dizziness which he encountered shortly after standing up after recovery. This was expected and is similar to the problem encountered by sick people when they first get out of bed following a long illness.

Another important result was the indication that changes in blood condition brought on by long periods of weightlessness are only temporary. Medical tests of Cooper showed that increased pulse rate and low blood pressure disappeared 36 hours after the flight.

Cooper also proved that man can sleep while orbiting in space. He said he had about five to six and one half hours sleep. "The sleep seemed normal, but slightly more sound" than on Earth, he said. ■

From balloon experiments . . .

Navy-NASA Program May Yield Scientist Astronauts

High-altitude project, funded jointly by BuWeps and OART, has multiple aims; DOD approval expected imminently

by Heather M. David

SCIENTISTS will get a chance to prove their worth as potential astronauts if a proposed Navy-NASA program is approved by the Defense Dept.

The experiment, part of a high-altitude, long-duration balloon flight program, will be one of many aimed at checking out space station equipment and components. It will pit scientists and others whose physical condition may not be as good as that of current astronauts against space equivalent conditions to see how they can cope with an operational situation.

Objectives of the program, jointly funded by Navy BuWeps and NASA's Office of Advanced Research and Technology, are:

—To provide tactical research for secret Navy projects.

—To research satellite tracking methods for the Navy.

—To test advanced Navy and NASA life-support equipment and space suits.

—To establish criteria for selection of long-term crews—including added requirements for using personnel chosen for scientific input—and to get other human factors data.

—To do psychological and confinement studies of how crews will work in free space.

—To get operational testing of new biomedical instrumentation and communications equipment.

—To research heat-transfer problems, crew escape and extra-vehicular operation.

• **Contracting**—A bidders' conference will be called by the Navy as soon as DOD approval is given. This is expected imminently. The major contract will be for a gondola, including a life-support system for up to seven men for as long as 30 days.

The gondola contract will include an outside platform for extra-vehicular research work and a connecting airlock. Hank Fedrizzi, Navy program chief, says current thinking is that the structure will be modular in type, and even a doughnut shape configuration has been considered. Aim is to test space station ideas.

The first contract probably will be for one gondola and a follow-on. Other modules may be added or other changes made as the program progresses. Construction of the basic gondola and platform is expected to take eight or nine months, setting the first launch about a year after the bidders' conference.

Another contract may be awarded for the balloon and launch services, although a single contract may be let if an industry team effort shows both capabilities.

The Navy will provide launching, tracking and retrieving facilities.

• **Life-support system**—The environmental control system used throughout the two- or three-year program is expected to be a standard, state-of-the-art type, probably stored liquid oxygen at 5 psi, Fedrizzi said.

Other experimental regenerative systems and new components will be phased in and out to test them. A number of different oxygen pressures and ratios will be tested by NASA in this program, NASA's program chief Dr. M. G. Del Duca told MISSILES AND ROCKETS. Feeding will also be experimental.

Experiments will be accepted from a number of sources—Navy and NASA labs, other government labs, private investigators and from industry. They will be evaluated and selected by a 10-man Navy-NASA management team headed by Fedrizzi and co-chaired by Del Duca of the Office of Advanced Research and Technology's Biotechnology and Human Engineering department.

• **'Numerous' flights**—Although the heads of the program will not commit themselves to the exact number of flights over the two- or three-year period, they do admit they will be "numerous rather than several." Three types of flights have been set:

—A three-man, three-day flight using only the basic module and basic equipment. An existing balloon of the 10-million-cu.-ft. class will probably be used.

—A 14-day flight, perhaps with a larger crew and added equipment.

—A 30-day, six- or seven-man-crew flight. Balloons for the longer duration flight will be designed by the Office of Naval Research for BuWeps. They probably will not exceed 15 million-cu.-ft. volume.

Launches may be by ship off the Pacific Coast or from the Gulf of Mexico, or even in the polar regions, depending upon the time of year. Recovery may be by land or sea.

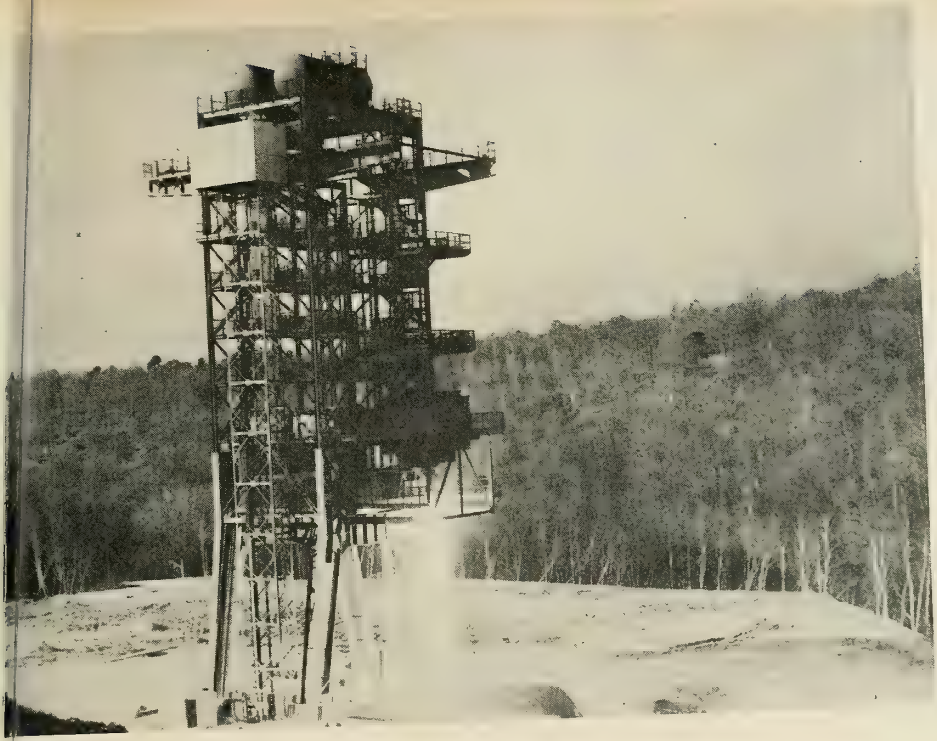
A major objective will be stability. The balloon will be moved up and down during the day and night—perhaps within a 150-mile radius—to position it against the winds. NASA is particularly concerned that the altitude be above 100,000 ft.

• **Crew**—Two members of the first crew have tentatively been picked. They are Dr. Stuart Raglan, Jr. (M.D.) a Navy doctor from Johnsville, Pa., and Gordon McCarty of Pt. Mugu, Calif. Each crew member will take only one trip, so many more crewmen will be chosen.

Although no age limits, pilot qualification or other rigorous standards have been set for the balloonists, they will have to pass medical examinations and Navy balloon school training.

This includes sea and land survival training, pressure-suit training (Navy or NASA) helicopter rescue and altitude-chamber checkout. Although no parachute training is now scheduled, parachutes or ejection seats will be aboard.

Navy members of the committee are Fedrizzi, Capt. Walter Jones and Lester Snyder, BuWeps; Dino Mancenelli, Navy Air Crew Equipment Laboratory, and McCarty. NASA's staff is not firm yet, except for chairman Del Duca. ■



FIRST PHOTO of 10-story static test tower at Vernon, France, on which large rocket motors for France's space program will be test-fired. Here a single nozzle motor is fired.

M/R exclusive . . .

French To Show Off 66-ft. Rocket

Display at Paris Air Show may give new impetus to Europe's space aims; official outlines Diamant's flight plan

LESS THAN 20 months after the
ational Assembly authorized the pro-
am, France's space agency Centre Na-
onal d'Etudes Spatiales (CNES) will
veil its 66-ft. *Diamant* space rocket
the Paris Air Show opening June 6 at
e Bourget Airport.

Crown jewel of France's precious
ones rocket series, the *Diamant* (Dia-
ond) evolves from *Agate, Topaze,*
meraude, Rubis and *Saphir. Agate* and
opaze are known to have been success-
ully test-flown several times, *Topaze*
nder guidance. Both are solid-fueled.

Diamant's display is bound to have an impact on Western European space plans centered on the multilateral European Space Research Organization (ESRO) and European Launch Development Organization (ELDO), which have yet to flex their muscles.

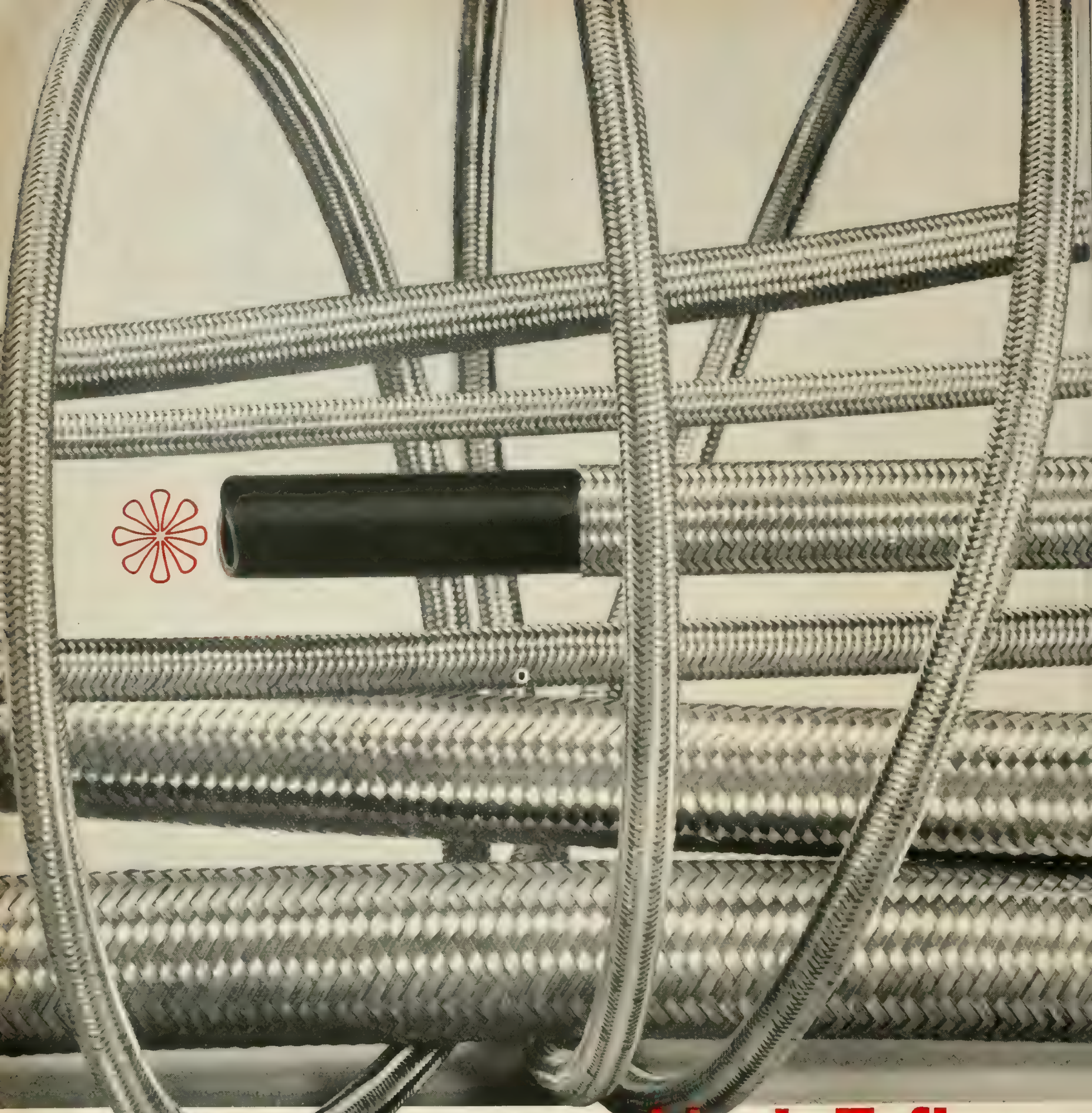
Exhibition of such a large rocket, about the same length as the U.S. Air Force *Minuteman* ICBM, or the NASA *Scout*, is expected to make it easier to get more funds for the space program. Insiders hint that France's national space budget will get a series of boosts adding up to quadruplication within the next 20 months.

Financing of the French space program is accomplished in two ways. There is a direct authorization, so far totalling about $15 million, plus a much larger indirect authorization which enables CNES to absorb techniques and hardware from the IRBM development program of which *Agate* and *Topaze*, for example, are a part.

See "IRBM Work Aids French Space Hopes" by Bernard Poirier; M/R, April 29, p. 55.

According to General R. Aubinière, Executive Director of CNES, the space rocket's first stage is liquid-fueled and has an outside diameter of 4.59 ft., about 14 in. more than *Scout*. Both upper stages use solid fuel.

- **Flight plan**—Details of a typical *Diamant* flight program have been made public by Technical Director M. R. Chevalier of France's IRBM agency, Société pour l'Etude et la Réalisation d'Engins Balistiques (SEREB). Much



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of *Diamant's* eventual success hinges on SEREB's contributions in propulsion reliability and system integration.

"The 39,600-lb. *Diamant* rises vertically," said Chevalier, "until velocity reaches 330 ft./sec." at which time its stabilization sensor initiates pitchover command. At 23 miles altitude and 19.8 miles downrange, burnout occurs as the vehicle is pitched to 40° off horizontal and velocity is about 5600 ft./sec.

The 31,240-lb. first stage, now spent and constituting a dead weight of 3740 lbs., is separated by means of explosive bolts at 88.5 secs. Second-stage ignition is signalled simultaneously.

The SEREB-provided second stage, modified from the 23-ft. *Topaze* IRBM test vehicle, has a 30-in. polyurethane grain weighting 5005 lbs. During the 42-sec. propulsion sequence, it develops up to 30,000 lbs. of thrust in vacuum.

During the powered phase of the second stage, the satellite fairing is jettisoned; at motor burnout 77 miles downrange and 62 miles high, velocity is 12,776 ft./sec. Time is 130.5 secs. and angle off horizontal is 33°. The vehicle will coast for about 270 secs. to ballistic apogee—250 miles.

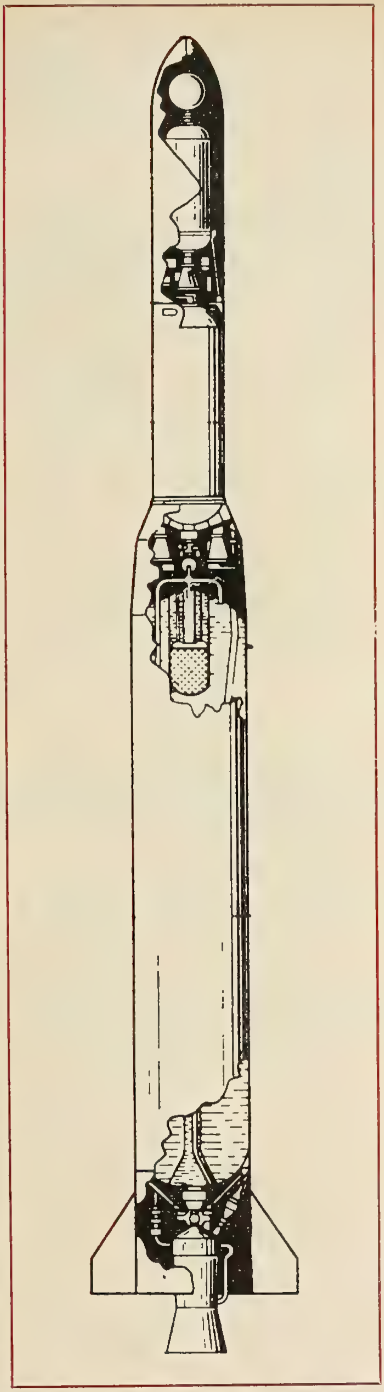
An intricate and crucial maneuver is programmed about midway in this coasting sequence. A JATO-type nitrogen jet pitches the vehicle over to a horizontal attitude to the Earth's surface and a spin-device-unit, probably small rockets, rolls the vehicle for flight stabilization. Proper attitude here determines the eventual success or failure of orbit injection of the satellite.

Staging is also programmed at the apogee where, to avoid disturbing third-stage attitude and roll rate, retro-rockets forward of the second stage are fired simultaneously with the release of pivotal latches under the interstage shell.

The single-nozzled, glass-fiber-wound third stage has a 26-in. polyurethane grain weighing 1430 lbs. and burns for 47 secs. Orbital velocity is attained just before burnout. Insertion of the satellite into orbit is at the same 250-mile altitude, some 750 miles downrange.

Only the first two stages have guidance. Two of the four fins located on the skirt of the first stage have controllable trailing-edge "ailerons." The modified IRBM second stage, as described by Chevalier, has four moveable nozzles to control pitch, yaw and roll during the powered phase.

- **Speed-up seen**—The first satellite mission foreseen for *Diamant* has been scheduled for early 1965, according to an announcement by Science Research Minister M. G. Palewski. It was later revealed by General Aubinière that the first satellite's orbital inclination to the equator is planned to be 30°, thus taking the satellite over portions of southeastern United States.



DRAWING of French Diamant space rocket. This version is 53.1 ft. in overall length with 32.6-ft. first stage, 9.5-ft. second stage, 11-ft. third stage. First-stage diameter is 4.59 ft. Liquid first stage uses 27,500 lbs. of kerosene and nitric acid. It reaches a maximum sea-level thrust of 28 tons during a total burning time of 88 secs. Upper two stages are solid-fueled. Configuration to be displayed at Paris Air Show measures 66 ft. in overall length.

However, the early showing of *Diamant*, together with the apparently successful flight tests of *Topaze* indicate the French might be able to move their satellite launching date into 1964 if more funds were made available. Many observers feel that *Diamant's* appearance at the Paris Air Show will make this inevitable.

Coupled to the half-billion-dollar ESRO/ELDO programs over the next few years, any sizeable increase in the French space investment would provide an annual European expenditure rate of almost $250 million through 1970.

The feeling among the experts in Paris is that economic growth in Europe supports the rapid increase of space-program investments. They cite the fact, for example, that in tiny Belgium alone more money is spent on tobacco and on alcoholic beverages in one year than the total anticipated ESRO/ELDO expenditures outlined for the next five years.

West Germany, which will provide the third stage of the European ELDO space rocket, devotes to drinking and smoking 9% of its annual gross national product of more than $90 billion.

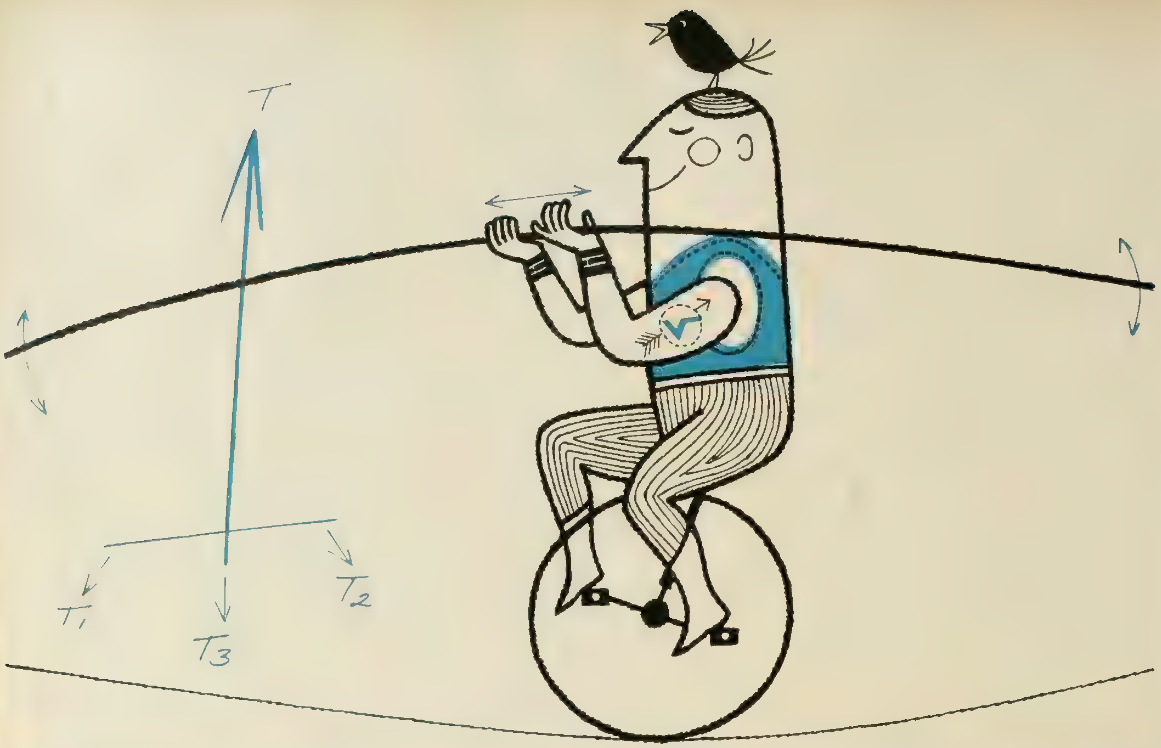
- **Versatility**—Multiple space roles for *Diamant* are hinted by French officials. Varying rocket configurations have already been disclosed. One modification has a length of 53.1 ft.; another, like the version to be exhibited at the Paris Air Show, is 66 ft. long.

A CNES spokesman said *Diamant* will be flanked at the show by *Véronique* and another newcomer to the public, *Rubis*. They will be located just before the Space Pavilion, a feature newly established by Minister Palewski for Europe's biggest air show, now to be known as the Aeronautical and Space show.

It was also revealed that CNES has established a joint coordinating council, Comité des Programmes Techniques du CNES. Among the members are top management personnel of all agencies involved in propulsion, metallurgy and structures, atomic and chemical energy, instrumentation, data reduction, guidance, telemetry, electronics, system integration and ground support equipment.

Council chairman Jean Voge is Chief Engineer of Communications at Centre National d'Etudes des Télécommunications (CNET), an agency with a primary role in France's first satellite attempt. The Council's first recommendations for coordinating the next three years of the space program were approved by the CNES Board of Directors on Feb. 23.

The plan virtually eliminates the possibility of costly duplication and authorizes continued research and development in propulsion, satellite design and orientation systems, telemetry and data reduction, and guidance. ■



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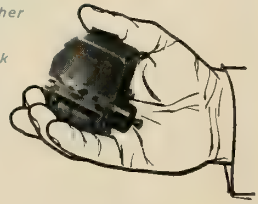
For details about this prototype pulse rocket development and other current attitude and thrust vector control programs ask for Bulletin No. A 5283-Y. Vickers Incorporated, P.O Box 302, Troy, Michigan.



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Technical Countdown

ELECTRONICS

New Life for BMEWS Tubes

Northrop Corp. is demonstrating for the Air Defense Command new automatic test equipment that may greatly extend the life of the klystron tubes, which cost up to $55,000 apiece, in the BMEWS network. Equipment is an outgrowth of Nortronics Div.'s Navy Advanced Radar Automatic Test Equipment (NARATE) program, which developed radiation sensors to automatically test radar installations while they are operating, thus considerably extending on-time. H. V. Bray, chief of applications engineering at Nortronics' systems support department, reports that the new equipment spots klystron tube malfunction before tubes can burn out and before personnel can be harmed by X-radiation resulting from maladjustment.

Ultra-minified Gyro Developed

Conventional gimbals have been eliminated in a new miniaturized rate gyroscope developed by Special Devices Laboratories, Inc., in South Orange, N.J. Called Telerate, the 1-cu-in., 1.5-oz. instrument develops an angular momentum of 62,500 gm-cm^2/sec., its designers say, and is believed to be the smallest rate gyro ever built. It employs an advanced synchronous motor to drive a hysteresis wheel. Output ranges include 10-2000 degrees/sec. with full-scale output at 1.5 volts and null at 5 mv. Resolution, according to the company, is infinite, linearity is 1.0%, and hysteresis is 0.01%. Starting time is 20 sec. Operating range is described as —54° to 100°C and units reportedly have been tested under shock and vibration conditions from 15 to 150-g. Unit price is quoted at "under $500."

Supersensitive Thermometer Uses Quartz Crystal

A quartz thermometer recently developed by Bell Telephone Laboratories is reported capable of measuring temperature changes as small as 10^{-5} degrees C. Employing a transistor circuit and new crystal-plate design, it detects thermal changes by association with corresponding frequency changes in a precision oscillator. The oscillator is controlled by the quartz crystal thermometer. Capable of operation from —269° to 100°C, the thermometer will permit detection of almost the exact temperature during change of phase of materials (e.g., from solid to liquid state).

New Deposited IR Sensor Has No Moving Parts

Barnes Engineering Company's new solid-backed thermopile infrared horizon sensor appears to have gained a strong foothold with spacecraft designers. Several configurations of the device are being developed for JPL, Raytheon, and Fairchild Stratos Corp. Its design makes use of the inherent thermovoltaic output of a thermopile, eliminating optical-mechanical chopping and scanning of incoming radiation common to widely-used thermistor and metal bolometer devices. This allows development of sensors with no moving parts, and also removes the requirement for polarizing or bias voltages which in certain conditions can obscure IR signal input. To handle low-level amplifier problems, Barnes developed a photo-conductive modulator in which solid-state photoconductor elements are illuminated by a pulsed light-source (neon lamps). Barnes says lasering action could be substituted in later designs.

Radar Astronomy Experiments Planned

Stanford Research Institute and Stanford University, supported by Air Force Cambridge Research Laboratories and NASA, plan investigations in bistatic radar astronomy utilizing *Mariner C, Pioneer* and *Surveyor* vehicles in 1964 and beyond. The investigations will use 400-kw (average) ground transmitters and small spacecraft receivers. The experiments will permit astronomers to send identical signals from a 150-ft. dish directly to a receiver in space while simultaneously bouncing them from the Moon or a planet to the space receiver. Changes in reflected signals, caught at different angles of reflection as the space probe moves along, are expected to reveal new and exact information about a celestial body's surface features, electrical characteristics and atmosphere.

PROPULSION

PneumoDynamics To Build Edwards Engine

A water-cooled research engine for testing and evaluating hypergolic liquid propellants will be designed and fabricated by the Systems Engineering Division of Pneumo-Dynamics Corp. for Edwards AFB, Calif. The unit will have an injector head, a cylindrical combustion chamber and a convergent-divergent nozzle. The nozzle will be contained in a stainless-steel shell with a molybdenum-alloy flame liner shielding the throat.

ADVANCED MATERIALS

Rolls-Royce Perfects Si Fiber/Al Material

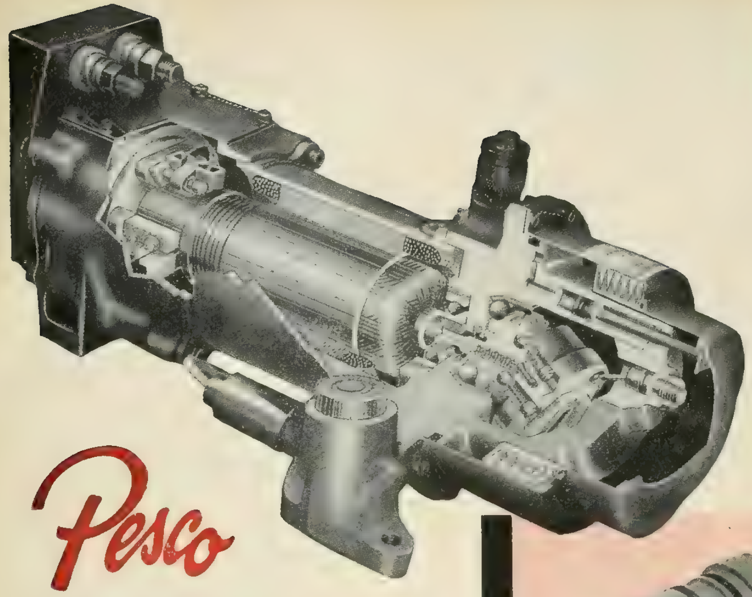
Extremely fine silica fibers coated with aluminum and hot-pressed into compact shapes by engineers at Rolls-Royce in England may lead to new material applications in re-entry devices, launchers and supersonic aircraft. The metal binds the fibers together so tightly that test specimens have withstood tensile stresses of 60,000 psi at 400°C. Investigators are studying other metal-ceramic pairs. Dr. A. M. Smith, chief of the research group responsible for the development, claims U.S. workers have not yet succeeded in coating the filaments with metal. The firm is also working on a thrust concept involving the burning of fuel on a suitably shaped external body. The project concerns a wedge-shaped satellite launcher first stage.

Control Formula for Percussive Welds

Bell Telephone Lab scientist James Coyne predicts that defective connections can be held to less than one in 10,000 through proper continuous welding controls in the percussive welding of wires to terminals. To control the process, Coyne advocates measuring the duration of the arc and the approach speed of the wire for each weld. A device can be set to reject welds automatically if arc duration is too short or too long. Coyne has developed a formula to determine the arc time ranges for high-quality welds between terminals and various types and gauges of wires.

Dynamic X-Ray for Gemini Parts Tests

A system built by Picker X-Ray Corp. will be used by McDonnell Aircraft specialists to examine the inside of *Gemini* components during operational tests. The complex also provides X-ray movies or stills ranging from candid to hospital X-ray sizes while the operator is visually examining the part. The part can be positioned and the radiation beam focussed while under direct visual scrutiny via the X-ray viewing screen. Moving the radiation source closer or away from the part permits image magnification on the operator's viewing screen.



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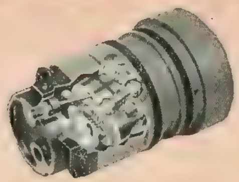

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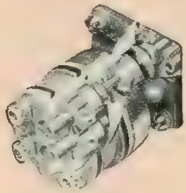

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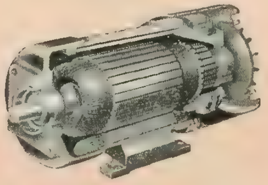

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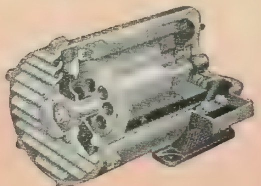

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Circle No. 7 on Subscriber Service Card

ARC Hard at Work On Development of Beryllium Powder

Company and Air Force feel that firings of additives in solids are as significant as previous aluminum powder successes

AERIAL VIEW of ARC's contained test-firing bay shows water deluge tank (center) and scrubbing stack (rear).

A SERIES OF solid-propellant formulations involving the potential high propulsive energy of beryllium powder instead of the more familiar aluminum are in active development at Atlantic Research Corp.

The alkaline-earth metal additive has been the object of an intensive research effort at ARC and other solid-propellant firms for some time. The metal's performance in any given propellant is classified, but it is known that the less dense beryllium contributes greatly to a higher temperature in exhaust gases.

Little information has been released about its effect on throat areas, or exactly how much of an increase in performance can be achieved. ARC experts do not anticipate a major problem in the nozzle area.

- **Early studies**—ARC first delved into Be early in the 1950's through theoretical studies. Subsequent support was provided by the Air Force and the Defense Department's Advanced Research Projects Agency. Current sponsorship is under the Rocket Propulsion Laboratory at Edwards AFB, Calif., funded by ARPA's Project Principia.

The Alexandria, Va., firm considers its development in beryllium—including firings—on a par with past successes with aluminum powder additives in solids. The Air Force agrees.

Except to say that the Be powder is treated in a manner similar to aluminum powder, ARC officials are unable to disclose any other handling details because of security restrictions.

- **Toxicity problems**—Beryllium and its compounds are toxic. Any industrial handling carries the responsibility of eliminating the danger to humans. This toxicity limits the additive to upper-stage applications in launch vehicles.

ARC's Chemical Engineering Division works in a selected, isolated and carefully engineered facility in the firm's Pine Ridge, Va. complex. Innumerable beryllium-containing formulations were processed during the search for the optimum ingredient mixtures.

The safety problem inherent in using beryllium powders extends to the test stands. Even these had to be completely enclosed and precautions taken to neutralize the motor exhaust gases. ARC officials describe the containment process as nothing more than the stringent application of known industrial hygiene processes.

The ARC enclosed chamber is 140 ft. long and 8 ft. in diameter with an enclosed volume of 7,000 ft.^{3} Motors up to 50 lbs. of propellant may be fired in the chamber but only relatively stable, well-tested propellants are fired at this level since the chamber can handle only 10-to-20-lb. motor detonations without serious structure damage.

During static firing, the nozzle blast is directed into a dense curtain of water. This has a cooling effect and impinges most exhaust particles with the water.

The exhaust gases are released to a Pease-Anthony scrubber, and then through a 75-ft. stack to the atmosphere. The scrubber liquid is chemically treated to assist in the absorption or neutralization of toxic gases or mist.

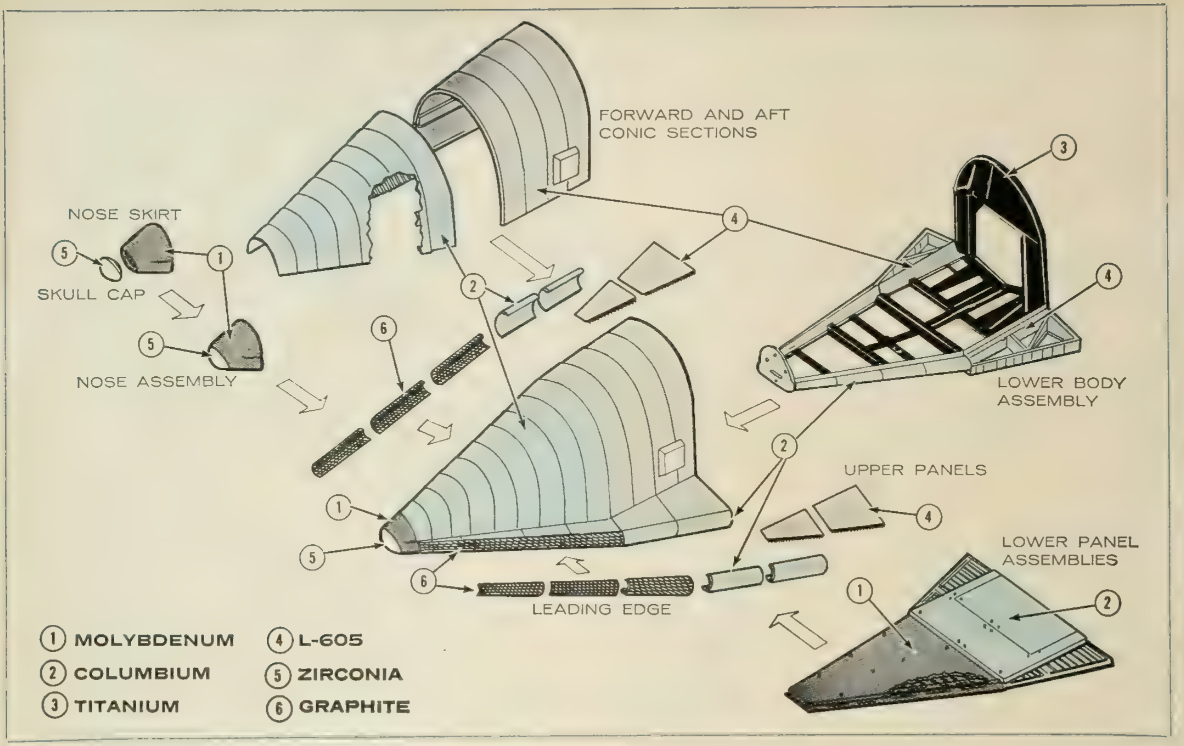
While ARC spokesmen admit the difficulties of quantifying the collection efficiencies of the separate parts of the system, net losses to the atmosphere range from less than 0.01% to 0.1% of the total toxic products in any given firing.

Mechanical pumping in the chamber enables it to simulate altitudes up to 150,000 ft. during 15-lb. firings.

- **Safety through isolation**—Since ARC studies indicate the safety for such operations is more readily attained by isolation rather than containment, the firm has acquired a tract of land on the outer banks of North Carolina, fronting on the Atlantic Ocean. The property is separated from the mainland by six miles of Currituck Sound.

ARC spokesmen see no barrier to using beryllium in any solid-fuel concept, including their own gel-solid innovation.

Research at ARC has led to the opinion that incorporating neutralizing measures in the propellant usually reduces the high-energy effectiveness of beryllium. The firm is also investigating other high-energy solid concepts. ■



advanced materials

ASSET To Test Hypersonic Theory

FLIGHTS OF the *ASSET* vehicles from Cape Canaveral will provide the first empirical confirmation of hypersonic aerodynamic and thermodynamic theory, yielding 17 minutes of near-steady-state data on materials & plasma conditions.

The launches, scheduled to begin later this summer aboard *Thor* boosters, will gather data through more than 50 thermocouples, as well as strain gages, accelerometers, pressure ports and other sensors.

The data gathering will cover all six basic materials used in the airframe, as well as forces acting upon the whole vehicle. *ASSET* greatly resembles the X-20 *Dyna-Soar* configuration.

ASSET, an acronym for Aerothermodynamic/elastic Structural Systems Environmental Tests, is expected to fill a part of the research gap which would be left by *Dyna-Soar's* absence at less than 5% of the X-20's cost. (M/R, April 29, p. 30)

The vehicle will be in a plasma sheath for an estimated one-third of its flight, and information concerning transmission through the sheath will be sought. On-board data storage will be used in addition to real-time transmissions, with the system being completely different from that carried by *Mercury* capsules.

- **Materials**—Zirconia, beryllium, titanium, graphite, L-605, and columbium are used in the airframe of the *ASSET* vehicle. Also used are aluminum and other standard metals and ceramics within the vehicle. Siliconized coatings will be applied to the airframe.

Prime contractor on the *ASSET* program, McDonnell Aircraft Corp., says the combination of exotic materials in the airframe presented unique problems in fabrication. In order to successfully operate the vehicle in the re-entry environment, McDonnell engineers developed new fabrication techniques as a part of the overall *ASSET* effort, in addition to new aerodynamic and thermodynamics aspects.

"The development of new processes and techniques for fabrication is often overlooked in the assessment of program significance," a company spokesman told MISSILES AND ROCKETS, adding that McDonnell has now acquired the necessary know-how to design advanced aerospacecraft "in the sure knowledge that their designs are predictably buildable."

- **Building block**—McDonnell sees *ASSET* as a building block of new technology in keeping with the Defense Department policy of acquiring new technology before going into final development of any major systems. *ASSET,* the firm says, is advanced technology.

The company cautions, however, against viewing *ASSET* as a complete substitute for the X-20 *Dyna-Soar* glider. *ASSET,* a spokesman explained, is simply an unmanned test vehicle that does not investigate aerodynamic maneuvering in its present configuration, and which will not have precise touchdown control. All vehicles will be recovered by downrange ships.

The cost of using such an unmanned vehicle is said to be one order of magnitude less than a full scale operational system. Two versions of the *ASSET* are due for launch in the program, with a total of six launches planned. All shots will be sub-orbital glides down the Atlantic Missile Range.

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NEW, 24-page manual, *Engineering with Silastic*, is now available. Contains design data. Write Dept. 6217, Engineering Products Division, Dow Corning Corporation, Midland, Michigan.

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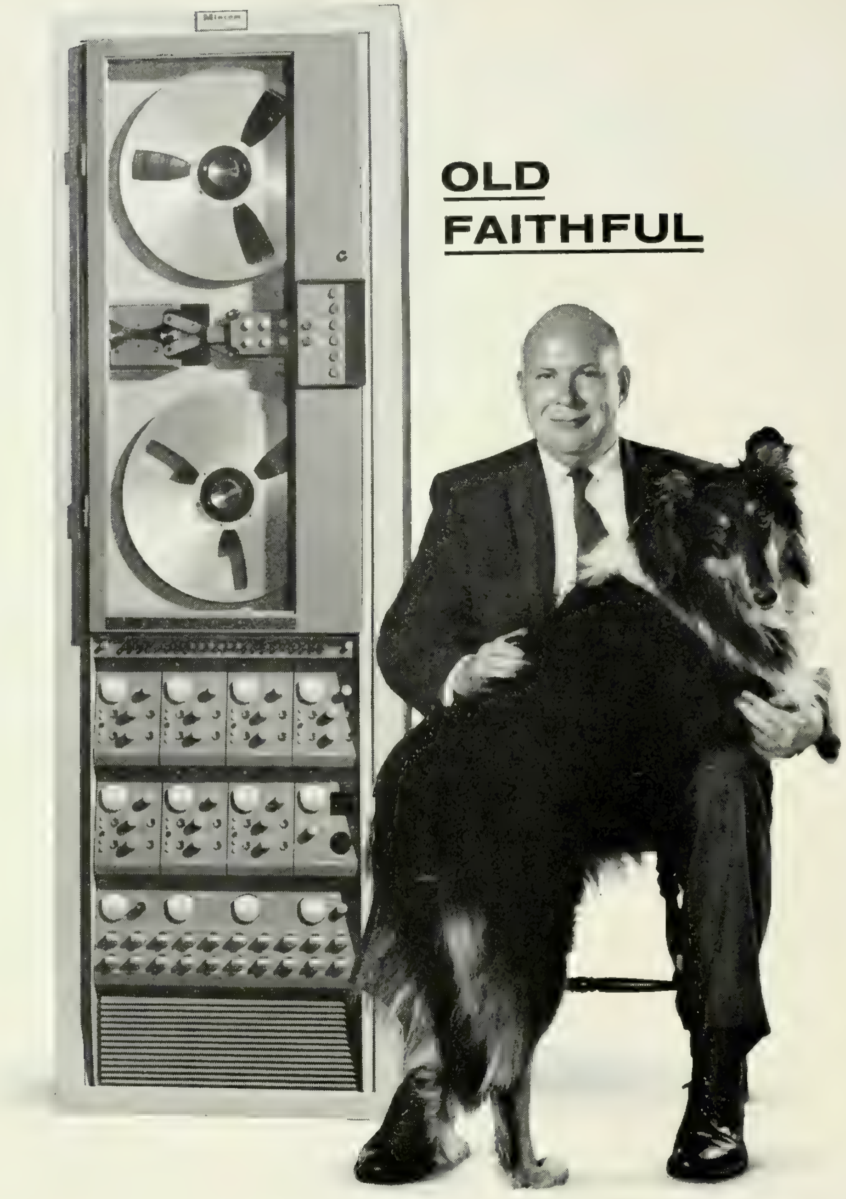

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Space Role Seen for New Computer

Burroughs applies magnetic core-rope techniques to handle complex logic functions; could be in orbital payload in year

by Michael Getler

PAOLI, PA.—Application of magnetic core-rope techniques to solve complex logic functions has led engineers at the Burroughs Corp. Research Laboratories here to development of a new lightweight, low-power digital computer with broad possibilities for missile and space system use.

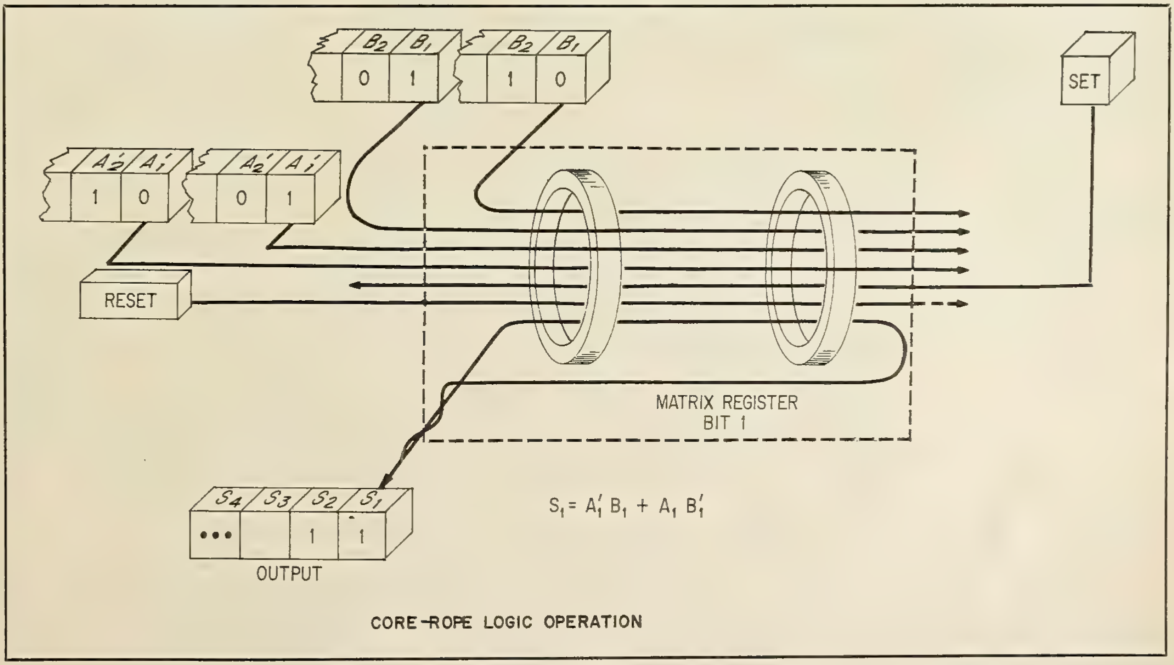
A unit based on the design of the new D210 magnetic computer will be delivered to the Air Force for environmental and acceleration tests this summer at Holloman Air Force Base, N.M. The firm says the device could be included in an orbital payload within a year.

Extensive use of magnetic circuitry instead of more radiation-prone components, controlled power requirements that vary proportionately with the computation rate, and achievement of required speed in handling complex logic equations allows solution of several mission checkout, guidance and navigation problems, Burroughs reports.

For example, in a sample mission profile, engineers here assert that pre-launch checkout of the computer and booster systems can be accomplished with the D210 operating at about one-fifth capacity. Complete pre-launch checks of all inertial guidance elements are also possible if program storage is available.

At liftoff, a short period of operation at the maximum clock rate (100 kc) can solve guidance, control and cutoff equations for orbital injection. In orbit, precise real-time navigation and computer self-checks can be performed at the minimum 1-kc rate.

(Continued on page 35, bottom)



SEGMENT of core-rope logic operation depicts key to high-speed solution of complex mission requirements.

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Paul Manship's powerful visage of Hercules symbolizes the strength and leadership of our modern-day Chemical Propulsion Division. After 50 years of experience in the field of propellants, it was inevitable that Hercules be linked with the aerospace industry. ■ An examination of contributions made to this industry shows Hercules as a manufacturer and creator of highly sophisticated propellant systems with guaranteed reproducibility. Hercules developed Spiralloy®, the lightweight, filament-wound structure for packaging energy. Revolutionary in design, proved by performance, accepted by the industry, Spiralloy allows space scientists to place weight where it belongs . . . in the payload. ■ More than 14,000 people in the Chemical Propulsion Division of Hercules made these advances possible. When future achievements are made in aerospace, or hydrospace, these people will be in the foreground. For detailed information on Hercules capabilities and facilities, write: Chemical Propulsion Division, Hercules Powder Company, Hercules Tower, Wilmington 99, Del.

HERCULES

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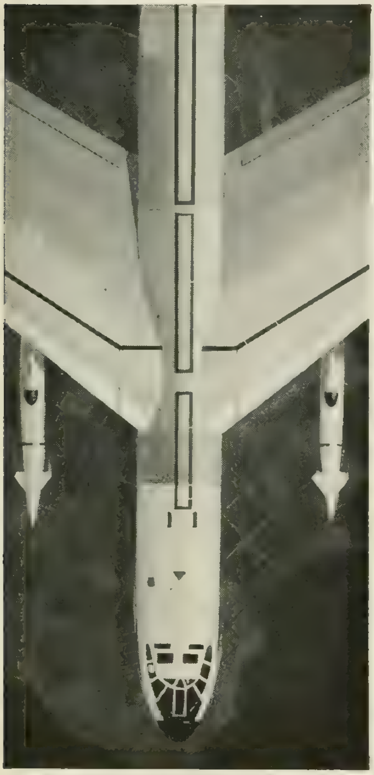
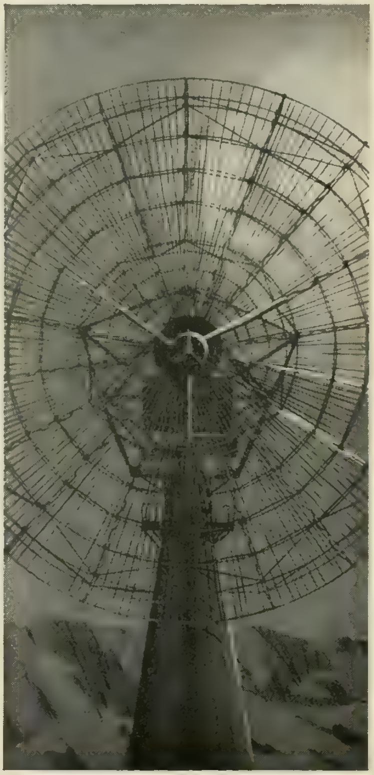


A Kellogg pump, a product of the Aerospace Division of American Brake Shoe, is an important part of the Garrett-AiResearch constant-speed drive—an efficient power source for aircraft cabin air compressors.



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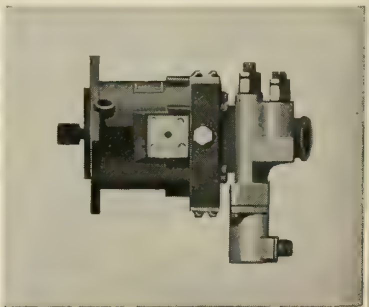
The Kellogg AP6VSC-6 pump, a single-stage, cam-actuated unit, is standard equipment on high-performance military aircraft and the Saturn I missile. The US Army's Chinook helicopter, produced by Boeing's Vertol Division, uses this pump as well as landing gear from Brake Shoe's Canadian subsidiary, Jarry Hydraulics, Ltd.



Circle No 8 on Subscriber Service Card

Space & Defense Group Seeks 10-15% Sales Hike

BURROUGHS Corp. is counting on its new Defense & Space Group, formed in January, to take up the slack in government sales expected to show this year as funding of three major programs draws to a close.

These three programs—SAGE data processors, *Atlas* ground guidance computers, and the ALRI (Airborne Long-Range Input) system for SAGE—have totaled about $425 million in business for the firm. They accounted for about $35 million in 1962.

As a result of the tapering off in these contracts, 1963 defense business figures for the firm are pegged at about $90 million, in contrast with $130 million in 1962. Last year's government sales represented about 25% of corporate business, according to Burroughs.

Citing improved efficiencies gained by the reorganization, and in particular a new drive "to improve the technical profile of the marketing force," Dr. Irven Travis, chief of the Defense & Space Group, told MISSILES AND ROCKETS that the group was forecasting about a 10-15% increase in '64 business over the expected '63 low. He expects the impact of the changes late this year. They should move the group ahead at the forecasted pace for '64 and beyond.

Travis says no major new facilities are planned, but he does see the group expanding its technical base in data processing into more peripheral areas, possibly ranging from input transducer devices to communications terminal equipment.

Dr. Irven Travis of Burroughs . . .
. . . has doubts about U. S. space program

There will also be additional emphasis on improving the man-machine interface, an area growing steadily in importance with the increasing complexity and data requirements of advanced missile, space, and command and control systems.

• **R&D a product**—Travis believes strongly that his group must sell R&D talent and capability, with success bringing natural follow-ons in production and field service awards. To do this, Burroughs is bringing more top technical talent into its marketing force.

As an indication of the significance the firm attaches to this technical sales force, Dr. Travis moved the former manager of Burroughs Laboratories Research Div., E. Gary Clark, into a vice president's spot as head of Defense & Space Marketing Div.

Some growth is envisioned in two other major Burroughs programs: the data-processing and communications complex—valued at about $10 million—going into the NORAD 425L system at Cheyenne Mountain, Colo., and a $24.5 million Air Force contract for the BUIC (Back-Up Interceptor Control) program.

The BUIC program will utilize pairs of Burroughs new D825 modular data-processing systems (M/R, Dec. 17, p. 34). This is a large-scale, military-oriented system with multiple computer memory, and input/output control modules.

In addition to new requirements for command and control systems, Dr. Travis expects a significant need will exist for so-called "store and forward" digital switching units for real-time programs in handling traffic of mixed priorities—for example military information networks such as the DEW line, SAGE, SPADETS, and future weather satellites.

Dr. Travis admits that his domain would be seriously challenged for new markets "if peace should break out." To adjust for this realistically, the firm continues to generate studies and plans on its possible course in this type of business climate. Travis feels other government agencies, possibly those more domestically oriented, could then become focal points for the larger budgets.

• **Space doubts**—Dr. Travis, a member of the U. S. Chamber of Commerce Committee on Science and Technology, has reservations about the aims and methods of the U. S. space program, and thinks "a lot of the glamour will fade in about three years."

While he has the highest regard for the manner in which NASA is carrying out its programs, he feels that the basic objectives handed to the space agency were wrong. Travis believes that much of this came about because of a Congress that has not been well informed.

He also feels that the NASA-type research now being conducted is not going to have the beneficial impact on the civilian economy that is generally expected, and claims the technical civilian fallout is exaggerated. ■

(Continued from page 31)

Computations required during reentry for trajectory selection and guidance would also require a relatively short period of high-speed operation. Clock rates are variable between one and 100 kc.

• **MTBF 47,000 hours**—Using high-reliability *Minuteman*-type components, MTBF predictions for the 19-lb., 0.25-cu.-ft. D210 computer approach 47,000 hrs.

With power consumption tied to computation rate, and the speed controlled either by external events or by the computer program, engineers envision an in-space life expectancy of several years for the unit on extended missions, which include long periods of relatively low computational demands. This should significantly reduce demands on spacecraft power and also reduce component degradation.

With this built-in "automatic gear shift," the effective operating speed and power can be exactly that dictated by the programmed inputs or the real-time requirements.

In contrast to more conventional on/off transistorized computer design, Burroughs says the D210 can remain on in standby condition, requiring only

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a fraction of a watt for power, while retaining the capability to process new inputs instantly.

Operating at full 100-kc capacity, requiring about 100 watts power, the computer, according to Burroughs, is the fastest magnetic device in operation with respect to speed and capacity. Operation times are: 24 bit add—30 microsecs; multiply—570 microsecs; and divide—640 microsecs.

The application of core-rope techniques to perform logic functions is based to a certain extent on the work Burroughs has done in core-rope fixed memories. The firm is a supplier of magnetic cores and ropes to Massachusetts Institute of Technology for use in the *Apollo* on-board computer memory.

According to Eugene Walendziewicz, developer of the system and logic concepts for the D210, "logic can be physically implemented with a device resembling the core-rope fixed memory but distinguished from it by certain novel characteristics."

- **Design philosophy**—Each core, he reports, can be viewed as operating like a decoder or an AND gate, while the sense lines behave as mixers or OR gates. The sense and inhibit lines can be threaded through the cores so that they implement these complex logic functions. Cores used in this manner are called "core null-decoders."

Walendziewicz points out that probably the most important feature of the magnetic logic technique is the extensive "fan-in" and "fan-out" capability available.

"Specifically, an input 'inhibit' line or an output 'sense' line can be readily threaded through several hundred core null-decoders. Similarly, any core null-decoder can be threaded by about 100 inhibit or sense lines or a combination of both. Relatively simple AND/OR gates are available which can handle at least an order of magnitude greater number of input variables than conventional electronic circuits. The same relative extension applies to the 'fan-out' of the input signals to and the output signals from the decoders."

In computer systems, addition is the basis for all other arithmetic operations, and the speed of the addition process, which affects time required for other operations, is generally limited by the time needed for the "carries" that are generated to move through the adder stages.

"In conventional electronic computers," Walendziewicz states, "carries ripple through the adders asynchronously, and at a much faster rate than the basic clock frequency." With magnetic systems, he says, this is not possible because each distinct operation must be synchronized by the comparatively slow clock. This has generally limited speeds attainable with magnetic devices to those obtainable through a serial addition process.

- **Simultaneous carry**—"In terms of logic, an extremely fast mode of computation results from parallel binary addition with simultaneous-carry—that is, where logic simultaneously examines the extent to which each carry originally generated will actually propagate.

"Equations for this type of addition have been known for some time, but their use in the design of a practical computing system utilizing conventional electronic circuitry was prohibitive because of the resultant high component counts and interconnection complexities."

The network for generating the simultaneous-carry terms for 25-bit numbers in efficient diode-transistor logic would require about 3,276 diodes and 351 transistors, engineers report, without allowance for the signal fan-out and fan-in limitations of the logic circuits.

WIRE BUNDLES are passed through and around cores in this D210 module. Computer weighs only 19 lbs., occupies 0.25 cu. ft.

"In sharp contrast," Walendziewicz says, "the same logic function can be implemented with magnetic logic techniques that have a total of 325 core null-decoders positioned along, and appropriately threaded by, a common bundle of 50 input, 25 output, and two control lines. The electronic circuitry (75 transistors) for the 50 inhibit lines and 25 sense lines can also be shared with other logic functions."

In its current configuration, the D210 employs three memories: a ferrite-core data memory providing storage for 256 24-bit words; a wired metallic-tape core program memory that can store 4,096 16-bit words; and a 256-core microprogram memory, each storing a 50-bit subcommand word. ■

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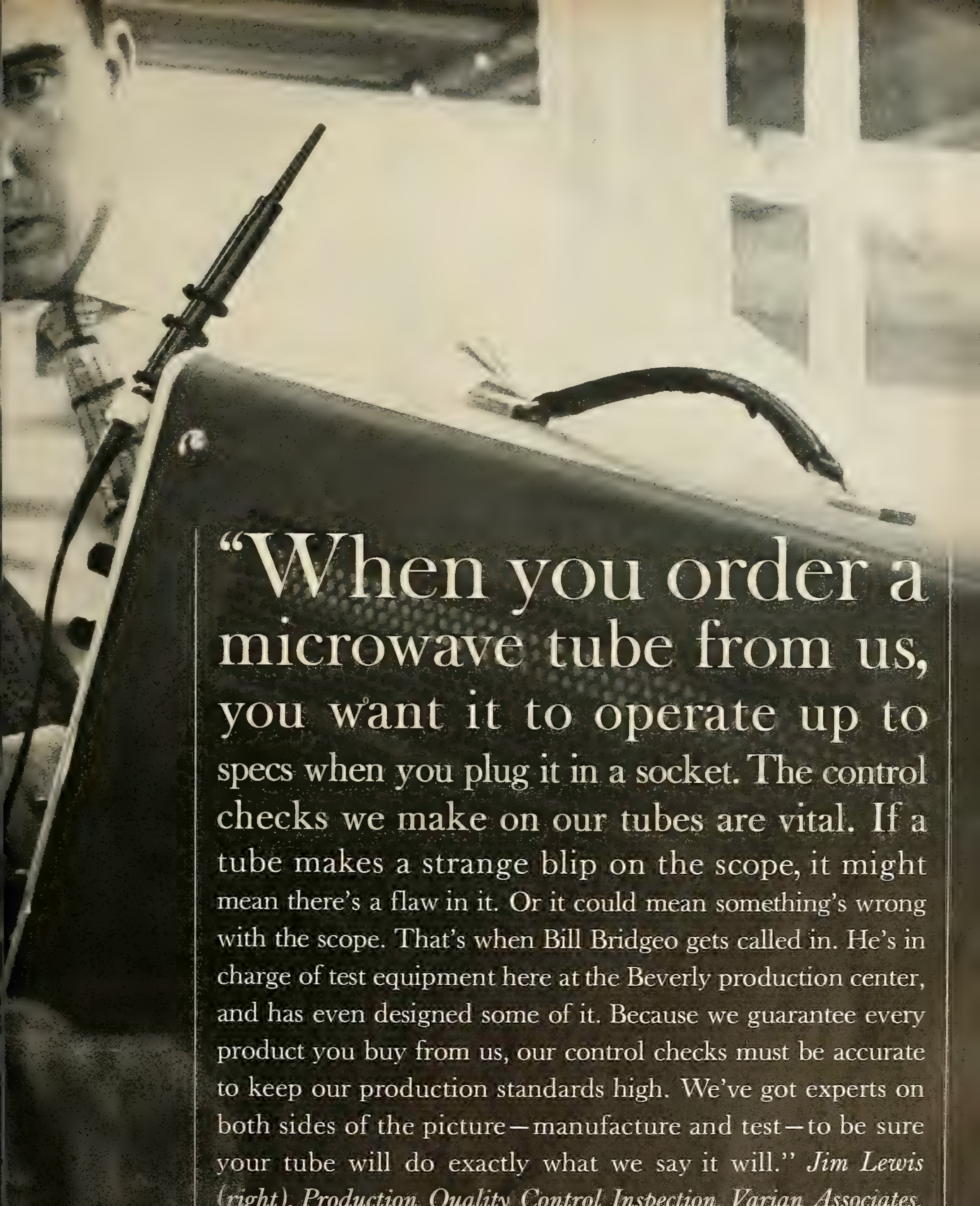

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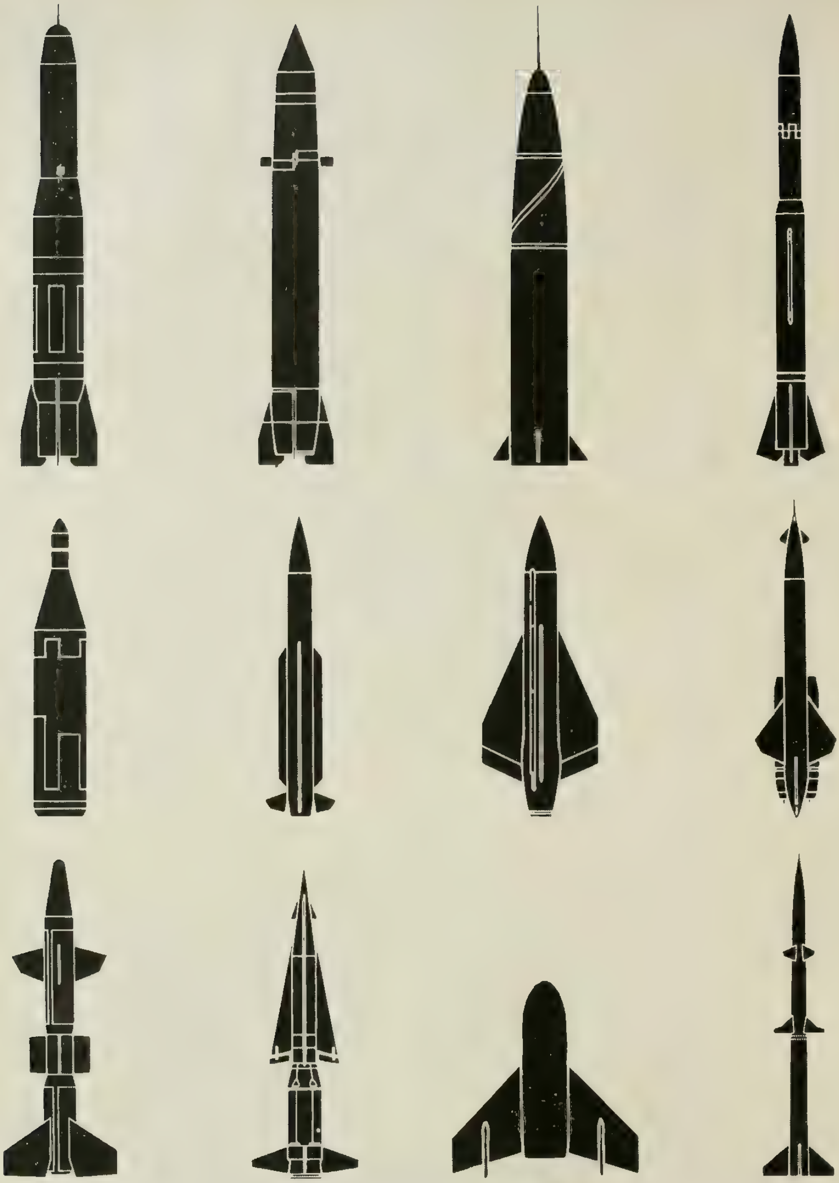

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Explosive Ordnance Systems Approach Advocated

McCormick Selph Associates trying to overcome current practice of splitting exploding bridgewire development between electronic and ordnance firms

by John F. Judge

HOLLISTER, CALIF.—A systems approach to the field of explosive ordnance in missile/space applications is being undertaken by McCormick Selph Associates, Inc. There seems to be only one major obstacle—a reluctance on the part of the firm's major customers to think of such ordnance in system terms.

McCormick Selph experts contend exploding bridgewire systems must be designed, developed and tested as a system instead of by the current practice of splitting development between electronic and ordnance firms.

When development of a particular exploding bridgewire system (XB) is divided through sub-contracts, the two developers are often unable to define an adequate working interface with the result that the independently produced subsystems fail to function as a complete system. This precipitates a crash program to iron out the interface and save the system, since it is frequently on a schedule tied to a major launch vehicle.

Electroexplosive devices are normally used to initiate stage separation, vehicle destruct and in other actuation applications aboard flying hardware. Within these applications a variety of specific functions may be incorporated into a single XB system—ignition, cable cutting, bolt and nut shearing, metal cutting and thrust termination.

Mc/S/A experts are convinced of the high reliability and safety of their system designs but concede a problem in educating the customer.

• **Other work**—In addition to bridgewire components, the firm is actively pushing mild detonating fuse assemblies. This method of transmitting energy through a cable-confined detonation is referred to as non-electric stimulus transfer systems (NESTS) and faces resistance in the market.

The basic concept of NESTS is not new, but the idea of confining the transmission of energy is relatively unique. A major objection is the lack of sufficient reliability data. This is not a valid argument, says R. C. Allen, Mc/S/A senior application engineer and originator of the NESTS concept, citing one area where an extremely large amount of such data is in supply. This is in the AEC, however, and a high security clearance is necessary to review the data.

In one case, a NASA installation adopted NESTS after a team went into AEC with the proper clearance. The result was the incorporation of NESTS-XB into sections of *Saturn V*.

NESTS utilizes only mild detonating fuses incorporating 2 grains of PETN or RDX high explosive per linear foot, contained in a 0.040-in.-dia. flexible metal tube covered, in turn, by plastic and fabric reinforcing material.

The fuse assembly may be routed anywhere in a vehicle with complete safety and no danger from shrapnel or heat. Inert manifolds can feed the confined MDF to any number of end functions from only one initiating input. The reliability, cost-savings and weight reduction here is obvious.

• **Unique ignition**—Another innovation is through-bulkhead ignition involving either a shock-type transfer system through solid metal walls or a self sealing system using compressed or compressable material to automatically seal the path of the detonating MDF.

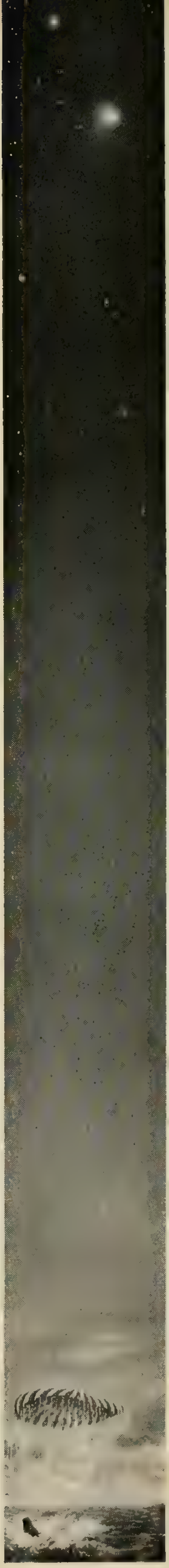
Using the shock transfer approach in a NESTS-XB system, the need for drilling, tapping or otherwise disturbing the unit construction of rocket engine cases can be eliminated.

The NESTS-XB approach eliminates need for ground checkout, although Mc/S/A experts have provided electrical systems accompanying the NEST network to test for cuts or separations in the system. As to the explosive content of MDF, Allen says slow neutron bombardment offers a route to pre-examination of the fuse before application. (The lead confinement used prevents ordinary X-ray examination).

Since activation energy is in the form of a potential chemical reaction, no supplementary power sources are needed. This coupled with absence of primary high explosives renders the NESTS system totally indifferent to practically all environmental conditions, man-made or otherwise, existing at any present or contemplated launching site and in any known launch vehicle.

Since the NESTS material detonates at a reproducible velocity of approximately 23,000 ft./sec., a properly designed NESTS-XB explosive ordnance system is the most efficient, economical, reliable and safest method known for the simultaneous initiation of various pyrotechnic functions, say Mc/S/A engineers.

• **No-fire safety**—XB components can be supplied that require electrical



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firing energy much higher than exists during aircraft or missile final assembly, shipping, field handling and check-out.

Allen lists some typical extreme no-fire design requirements as follows:

—No fire and operative on application of up to 25,000 volts, 120 million joule pulse.

—No fire and operative on application of a-c or d-c potential from any source up to 1000 volts.

—No fire but may dud (rendered inoperative) on extended exposure to high temperatures, but operative when exposed for limited times (10 sec. to 2 hours) in range 200-2000°F.

—No fire and operative when exposed to an RF field of 100 milliwatts/sq. cm. over frequency range 2-30,000 megacycles.

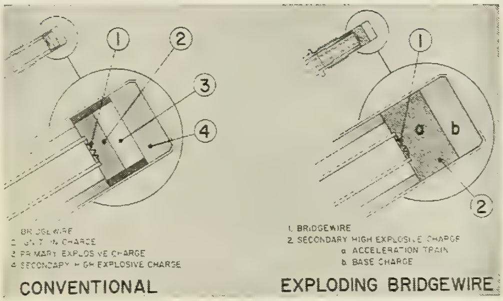
Mc/S/A considers itself more an ordnance/electronics systems engineering firm than a straight-line ordnance business and contends this is the only route to reliable ordnance systems on vehicles.

The modular concept, now accepted on all missile systems carrying XB systems, was started by Mc/S/A. The firm's engineers solved high-voltage, high-altitude interfaces with a proprietary connection.

Another innovation covers the use of metallized and brazed alumina for reliable pin-pin and pin-case connections. The use of XB initiation with extremely small quantities of PETN (40 milligrams) was advanced by the firm when the ordnance industry was convinced that nothing less than 300 mg could be used. This is now accepted and is incorporated in the Army's *Pershing* missile.

The firm has a production contract on the *Pershing* XB system and is also moving the NESTS-XB concept into the *Saturn V*. There is also Mc/S/A ordnance in the *Polaris* systems.

Exploding Bridgewire Critics Answered



The exploding bridgewire (XB) phenomenom consists of exploding a fine wire by passing a relatively large pulse of electrical energy through it in a short period of time. The major contribution of XB to explosive ordnance is in the elimination of all sensitive primary explosives. Properly designed XB initiators are insensitive to all physical and electrical shocks, including stray current, RF energy, normal electric power and even hammer blows.

The basic McCormick Selph module consists of an XB initiator, cabling, triggered gap and associated circuitry and a storage capacitor with associated circuitry. This modular approach, developed by Mc/S/A, eliminates the need for a centralized XB firing unit initiating XB devices over long lengths of high voltage cable. The modular approach increases reliability, decreases weight and volume, requires a minimum of high voltage cabling and makes parts interchangeability possible.

The system is armed by charging the capacitor. The disarm function is achieved by removing the arm signal and allowing the capacitor to discharge through a bleed resistor in the module. Firing is accomplished by providing a coded signal to the triggered spark gap.

- **Gap switch defended**—Much criticism of XB systems is focused on the triggered gap switch. When the system is armed, the gap switch is the only hold-off device preventing capacitor discharge and system function.

The criticism involves sensitivity of the triggered gap switch compared to that of its conventional hot wire counterpart and its susceptibility to activation by nuclear radiation. Mc/S/A spokesmen point to thorough testing of triggered gap switches by primary manufacturers with regard to pre-fire reliability. These included magnetic fields up to 10,000 gauss, nuclear radiation, heat, shock, vibration and hold-off tests involving the application of 3000 volts for 24 hours.

Normal shielding and care in wiring the triggered gap circuitry will eliminate pre-fire breakdown under extreme high voltage gradients.

R. W. Lynch, director of electro-explosive systems at Mc/S/A, says the main characteristic of a spark gap that must be understood is that it is a non-linear voltage element. Contrary to a widely-held misconception, says Lynch, a triggered gap does not have either an infinite impedance or none.

It can, under certain circuit conditions, present a high impedance and dissipate a large proportion of the available stored energy in its own volume, providing a proportionately small amount to the load. Lynch feels the failure to understand this possibility may be the root of some of the troubles plaguing certain XB applications today.

Lynch says the non-linear characteristic of gaps does not have to be of concern if one simple precaution is observed—all XB circuits including gap breakdown testers should be designed such that all spark gaps are operated in the arc range.

Other common misconceptions:

- **Arming Time**—The prevalent thought is that XB systems require a minimum of 4 seconds to arm; but Lynch says one major flying XB system in a missile arms in less than 0.225 sec. using a maximum current of 0.45 amps from a 115 volt a-c source. Another major system takes 7 seconds, showing the wide flexibility in arming time.

- **Cabling**—It is often said that typical XB systems must use coaxial or triaxial cabling and connectors; but Mc/S/A systems usually involve simple twisted, shielded pairs.

- **Single Configuration**—While the current modular concept involves a single bridgewire and redundancy is achieved by paralleling the complete module, there is no reason why multiple bridgewire units could not function even if the first initiated failed.

- **Spark Gap**—System reliability and safety can be achieved over a gap breakdown range in excess of 650-1400 volts using tolerances of thousandths.

- **Firing Unit/Initiator Ratio**—While some systems do use a separate firing unit for each initiator, it is possible to program several outputs using a single firing unit and incorporating a triggered gap and output connector for each initiator. By including an MDF transfer system unlimited initiation points can be provided with one unit ■

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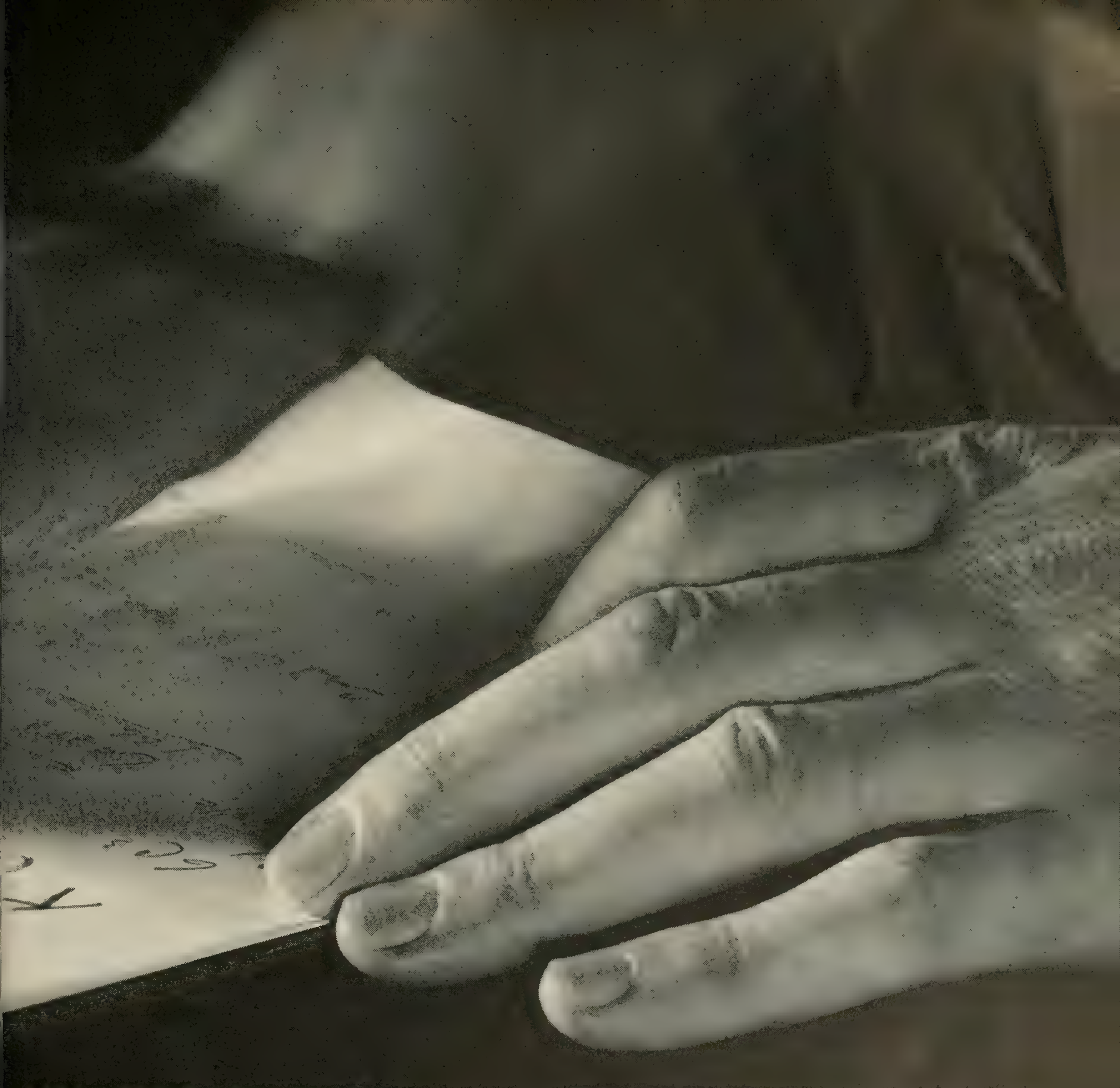

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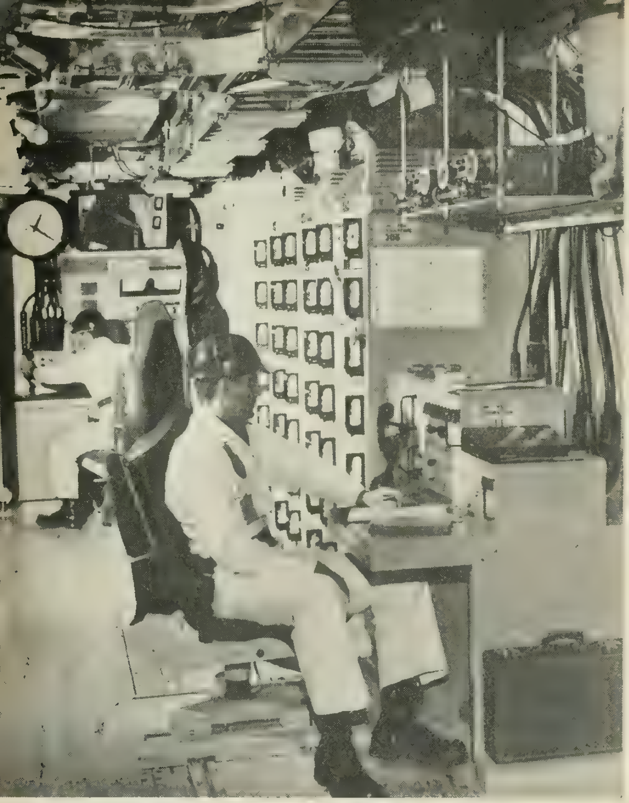


Big White Room Assembly Raises ICBM Reliability

Radio Corp. of America claims that early goals have been exceeded in Minuteman's Wing I ground communications equipment

MINUTEMAN underground launch control center manned by two SAC officers. Master panel (rear) displays status of each missile.

CAMBRIDGE, OHIO—Engineers of Radio Corporation of America, turning out ground-based communications and control equipment for *Minuteman* ICBM sites in a huge new "white room" production facility here, say the reliability of already-delivered Wing I equipment may actually have reached the levels projected for Wing IV missiles.

Major element in the ground equipment RCA is supplying under subcontract to the Boeing Co. is the sensitive command network (SCN). Essentially, the SCN includes rack-mounted data-processing equipment with underground cable links between individual manned launch control centers and unmanned missile silos.

Each silo houses two equipment racks and each launch control center (which controls 10 missiles) contains three racks. As a rule, each 150-missile *Minuteman* Wing is made up of three 50-missile squadrons.

Under a contract valued at about $200 million, RCA will supply the command network and associated equipment for Wings I and II, and portions of the equipment for Wings III, IV, and V. Hughes Aircraft Co. also will supply portions of this equipment for the later wings.

For the first *Minuteman* Wing, now operational at Malmstrom AFB in Montana, RCA engineers report a 25-hour mean-time-before-failure (MTBF) was predicted for the SCN equipment associated with an entire 50-missile squadron (theoretically, no component within a squadron's SCN gear should fail in this period). However, reliability engineers here report that operation of Wing I equipment now in service indicates figures significantly beyond the 25-hour level are being realized.

- **Reliability growth**—With reliability growth a basic principle of the entire *Minuteman* program, RCA engineers estimate that MTBF figures will rise to about 60 hours for the SCN gear in later wings. The 60-hour MTBF mark translates roughly to the overall stated component-level reliability goal of an average maximum failure rate equivalent to 0.001% per 1000 hours.

The firm reports that its "white room" assembly area is now at a peak production rate on equipment for the first Wing II 10-missile flight going in at Ellsworth AFB, S.D.

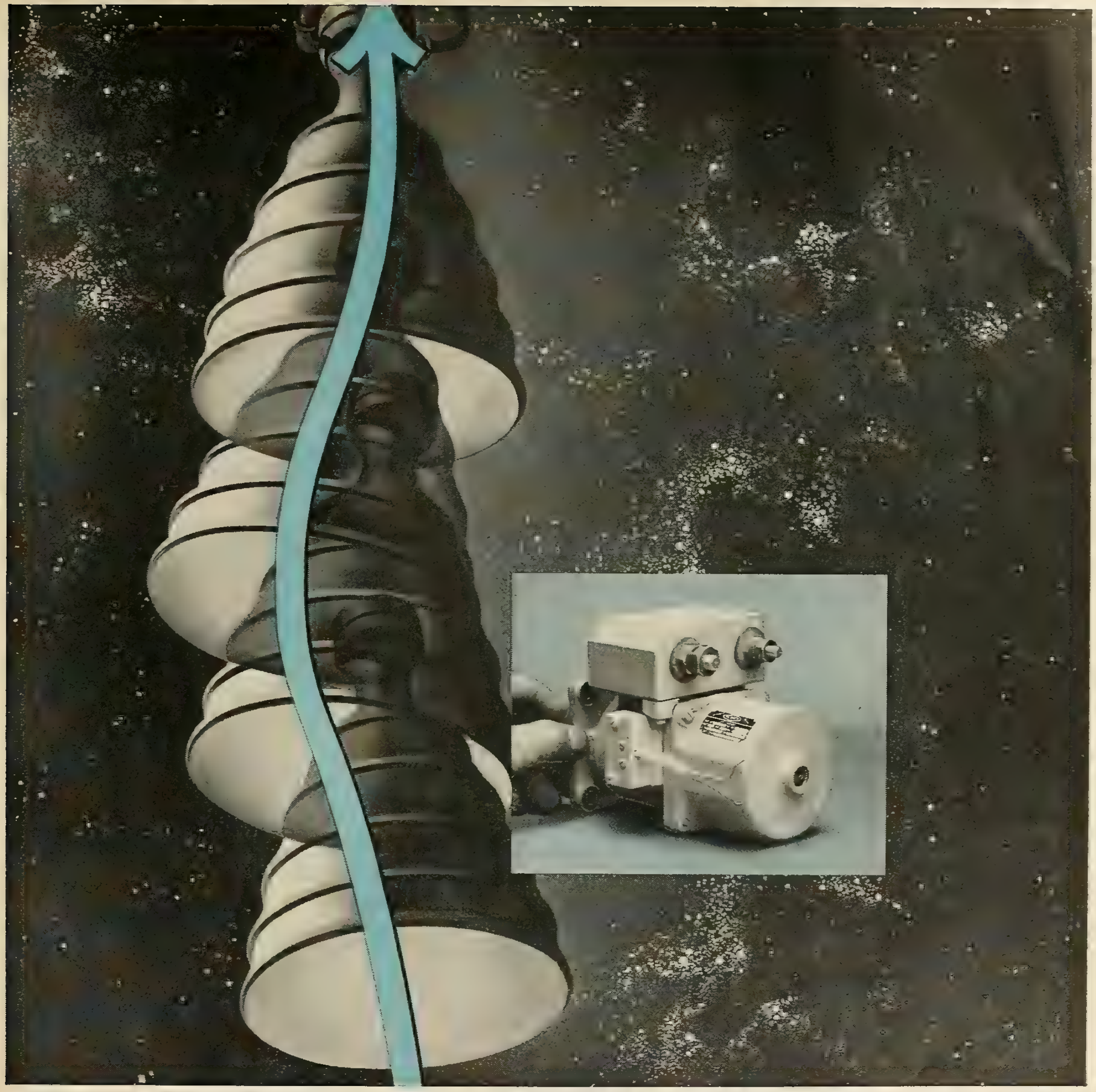
The impact of the large-scale "white room" assembly on reliability is difficult to measure exactly, but RCA production managers feel strongly that development of this facility and the assembly procedures has made a major contribution to achieving the ultra-high reliability goals which characterize the *Minuteman* program.

The recent expansion of the "white room" to 72,000 sq. ft., makes it the largest facility of its kind in the world, RCA claims. More than 700 persons work within the various bays.

Categorized by the Air Force as a class 2½ white room, the plant has a temperature environment controlled to 72 ±2°F., and its relative humidity is kept at 45%. It is reported that the filtering system keeps the airborne dust count for particles of 10 microns or larger at less than 1000 parts per cu. ft. Illumination at bench areas is in excess of 100 ft.-candles. Also, a slight pressure (0.125 in. of water) is maintained within the facility to avoid influx of any external "contaminated" air from beyond the entrance air locks.

Prior to inclusion in communications equipment modules, RCA reports, all high-population electronic components, both RCA and vendor-supplied, are put through extensive incoming preconditioning tests. These range from about 250 hours for capacitors to 500 hours for resistors and semiconductors.

During assembly operation, RCA says, it has used wire-wrap connections wherever possible in lieu of solder joints, which engineers say have been the weakest link in moving towards required reliability specs. They point out that experienced material inspectors have difficulty determining the adequacy of solder joints. ■



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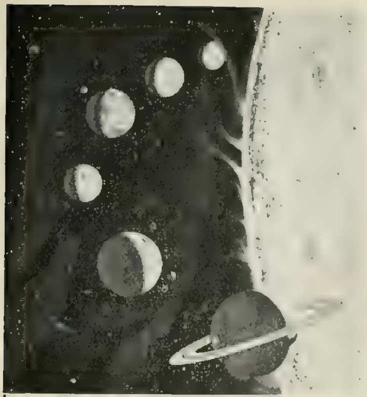

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Laser Modulation Could Spur Audio Space Role

Recent developments indicate solution of laser diode cooling obstacle within year

NEW YORK—Successful modulation by IBM engineers of a gallium arsenide (GaAs) injection laser beam to achieve audio transmission may focus increased attention on these devices as perhaps the most practical route to early use of lasers for space communications.

IBM reports combination of relative efficiency of injection laser operation and simplicity of the associated modulation circuitry, in comparison to other CW and pulsed devices, could lead to several possible roles.

At this point, one major economic and packaging stumbling block to their eventual use in space is the need to cool the laser diode to liquid nitrogen temperatures. Some scientists, however, commenting on the unexpectedly rapid pace of injection laser developments (operation of the first device was reported last November) predict that within a year the lasers might be made to operate under ambient conditions.

Though any ground-to-space laser communications link will be limited to a few terrestrial locales because of inherent atmospheric attenuation, ability to effectively package these devices for on-board use could expedite many space-to-space communications uses and also lead to development of intra-spacecraft systems to replace some traditional coaxial links.

Additionally, some observers feel possible future experiments using injection lasers for communications between spacecraft and aircraft could lead to a global manned spacecraft communications network with good capability for high-frequency penetration of the plasma sheath during re-entry.

- **PFM key to system**—Key to the IBM experiment is the pulse-frequency-modulation (PFM) technique developed by Kenneth Neibuhr and Robert Green at the firm's Federal Systems Div., Bethesda, Md.

The modulation circuit, which essentially varies the frequency of laser emission in proportion to the incoming information signal, basically consists of a delay line whose charge time can be controlled. When the line voltage reaches a pre-set level, a four-layer diode at the end of the line breaks down, discharging a 0.2 microsecond five-amp pulse through the GaAs diode laser (which has a 2¼-amp threshold).

The charge time of the line, and therefore the frequency of the laser pulse train, is controlled by the amplitude of the information signal through a transistor-type variable resistance element. Impedance of the modulation circuit matches the one ohm injection laser impedance.

According to IBM, this type of PFM, which has inherent noise-suppression capability, tends to minimize average transmitter power and hence diode heating required for a given data rate. Reduction in transmitter power, they point out, is achieved at the relatively minor expense of a wider receiver bandwidth than would be required for simple amplitude modulation.

In addition to higher efficiency, IBM says significant advantages of the lasing diode over the non-lasing type stem from its spatial coherence, which allows power to be concentrated in a narrower beam with efficient optical systems; and also from its time coherence, which permits greater daylight transmitting range because background radiation can be more efficiently filtered.

They also note that PFM allows use of a relatively unsophisticated photomultiplier detector and pulse frequency discriminator (demodulator) at the receiver.

The IBM laser transmitter operates at an average pulse repetition frequency (PRF) of 12 kc per sec. In initial experiments, IBM reports transmission of audio signals from 300 cps to 3 kc. Engineers say PRF could be extended beyond 30 kc to perhaps 100 kc with relatively minor circuit refinements.

Peak power input for the experimental set-up was 10 watts. Peak output was ¹⁄₁₀ watt. ■

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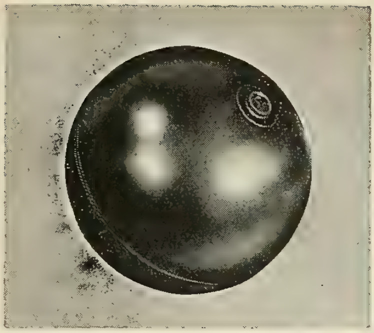
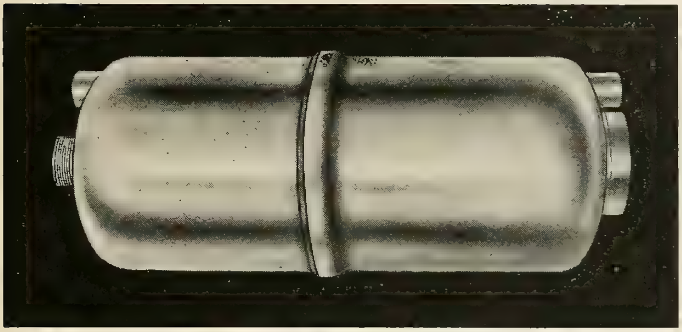
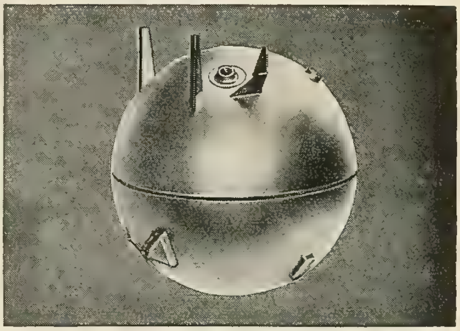


Ultra High Strength Steel, Missile High Pressure Storage Vessel

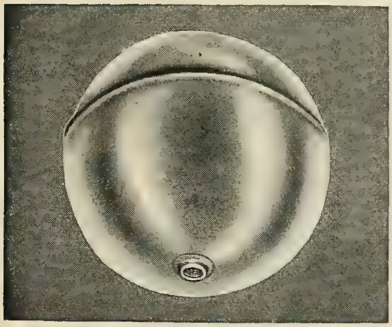
Titanium Alloy, High Pressure Storage Vessel, Missile Attitude Control



Aluminum Alloy, Zero G Positive Expulsion Missile Attitude Control Fluid Storage Vessel



Precipitation Hardening Steel, Missile Lubricant Reservoir



Titanium Alloy, High Pressure Vessel

Precipitation Hardening Steel, Drone Coolant Storage Vessel

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JPL tracking antenna does it with high accuracy hydraulic power for drive and control

Tracking objects thousands of miles deep in outer space calls for fast, smooth action and extraordinarily accurate control. The new 85-foot diameter receiving antenna pictured here is operated for NASA by the California Institute of Technology Jet Propulsion Laboratory.

The 30-ton parabola is driven and held "on target" by Denison hydraulic power. This 110-foot high receiving antenna—located at Goldstone Tracking Station, California—tracks and communicates with spacecraft in the U.S. space exploration program.

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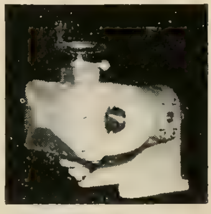

VARIABLE VOLUME AXIAL PISTON PUMPS (Denison Series 600) supply hydraulic power to main drive system of JPL tracking antenna.

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New Firms and Divisions

Central Technology, Inc., a newly formed missile/space company, has established operation in Herrin, Ill. CTI is engaged in design, R&D, testing and production of mechanical, electromechanical, electronic, pneumatic and chemical components. . . . *Harmonic Drive Div. of United Shoe Machinery Co. has opened a Los Angeles office to offer engineering and sales information to West Coast missile/space companies. Current applications for HD developments include special winches for space capsule flight control; precision capstan and scanning drives; and high-torque servo actuators for missile control.* . . . Aerojet General Corp., Azusa, Calif., has established a Life Support Systems Div. The division is to work on problems involving the support of man in space, undersea, and in other unnatural environments. The division is also to provide a corporate focal point for development and manufacturing of life-support systems, research facilities and protective equipment. . . . *Dorr-Oliver, Inc., Stamford, Conn., has established a subsidiary, Dortech, Inc. DI will operate from the DO headquarters in Stamford and offer project management and engineering in the general area of aerospace ground support equipment and related facilities.* . . . Televiso Electronics, Wheeling, Ill., a division of Doughboy Industries, developers of ground-to-air aids to navigation, is expanding into the missile/space field. Firm's initial plans include guided and manned missile ground support equipment.

Mergers and Acquisitions

General Technology Corp., Torrance, Calif., has acquired Scientific Quartz & Metals, Inc., of Long Beach. SQ&M designs and manufactures quartz, glass, tungsten and refractory metals apparatus for scientific research and industrial applications. SQ&M will operate as a division of GTC. . . . *Rocket Power, Inc., Mesa, Ariz., has purchased Paranetics Co., El Monte, Calif., supplier of equipment in the sport parachuting field. The acquisition is said to be in line with the firm's plans to move into the supply of sounding rockets, catapults and related equipment for use in pilot and astronaut escape systems.* . . . International Telephone and Telegraph Corp. has assumed control of General Controls Co., Glendale, Calif., producer of automatic controls for missile/space and industrial use. . . . *Teledyne, Inc., Hawthorne, Calif., electronics firm, has acquired Control Dynamics Corp. of North Hollywood. CDC manufactures miniature relays for space applications.* . . . Scionics Corp., Canoga Park, Calif., has acquired Pacific Southwest Instrument Laboratories. SC manufactures microminiature and hermetic seal ceramic capacitors and microfilm aperture cardmaking equipment. PSIL's environmental chambers for precision temperature testing of electronic, space and missile components and its temperature controlled centrifuge test equipment will be added to the facilities of SC's instrumentation div. . . . *Beckman Instruments, Inc., Fullerton, Calif., electronics firm is acquiring Sharp Laboratories, Inc., La Jolla. Sharp is a developer of nuclear instrumentation. Plans are for a pooling of interests based on exchange of some 24,000 shares of Beckman common stock for the assets of Sharp. Proposal is still subject to Sharp stockholder approval.* . . . American Precision Industries, Buffalo, N.Y., has acquired the Electromechanical Div. of the Carmody Corp., also of Buffalo. The Electromechanical Div. manufactures miniature magnetic brakes and clutches used in missiles and aircraft.

Representatives Named

Gentry Associates, Inc., Orlando, Fla., has been named sales representative for Dorne and Margolin, Westbury, N.Y., manufacturer of antenna and other microwave devices. Gentry will represent D&M in Florida, Georgia, Alabama, Mississippi, and Louisiana. . . . *Saffro Associates, Chicago, has been appointed sales representative for Power Designs, Inc.'s line of regulated power supplies in the Chicago-northern-Illinois-southern Wisconsin area. PDI is headquartered in Westbury, N.Y.* . . . E. A. Dickinson & Associates, Inc., Milwaukee, has been named industrial sales representative for the electronics division of Globe Union, Inc. Dickinson will call on GEM accounts in northwestern Wisconsin, Minnesota, South Dakota, and North Dakota, and will sell Centralab variable resistors, switches, ceramic capacitors, PEC integrated circuits, and technical ceramics. . . . *Bonn Associates, Inc., Metuchen, N.J., is new sales representative for American Electronics Laboratories, Inc., in New York City and Long Island; the states of New Jersey, Delaware, and eastern Pennsylvania, except greater Philadelphia. AEL manufactures microwave antennas, diodes, and electronic test equipment.* . . . B&K Instruments, Cleveland, specialists in sound, vibration, and data-analysis, has opened a field office at Los Altos, Calif., to provide engineering and sales representation to customers in northern California and Nevada.

Industry Facilities

Radiation, Inc., Melbourne, Fla., has expanded its reflectivity measurements facility to include a system operating in the L-band range and a UHF system using CW transmission to provide an overall frequency range of 550 mc to 24 kmc. . . . *The Martin Co.'s Orlando, Fla., Div. has begun construction on a $2.5 million facility expansion. The 127,800-sq.-ft. research center will provide laboratories and work space to consolidate and enlarge the division's research activities, which currently include electromagnetics, electronics, physical sciences, aerospace physics, structures and mechanics, and materials.*

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* You'll be hearing a great deal about Project Vest. A new approach to telemetry! It's a **V**estigial **S**ide**B**and frequency modulation instrumentation system that extends wideband data capability to DC. ■ VSB/FM is an outgrowth of the Ortronix single sideband telemeter currently programmed for such advanced missile systems as Saturn. Vest has an increase in total bandwidth capability of *thirteen to one* over standard FM/FM systems. Fifteen 3 KC channels in 75 KC of subcarrier bandwidth. Compatible? Yes! Vest can be used with any standard FM telemetry transmitter, receiver and tape recorder. ■ Company funded . . . Vest is another example of the challenging, sound and creative engineering spirit existing at Ortronix. ■ If you'd like more information on Project Vest, please write direct to our Sales Manager. Or . . . if you are seeking to further advance your career and work in a free and dynamic atmosphere . . . then write to our Director of Engineering.

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contracts and procurements

AWARDS

AIR FORCE

$18,847,765—**Federal Electric Corp.,** Paramus, N. J., for the operation and maintenance of the Distant Early Warning (DEW) System during 1964 fiscal year.

$15,450,000—**Carrier Air Conditioning Co.,** Syracuse, N. Y., for building environmental control systems for two *Minuteman* missile complexes.

$9,000,000—**General Motors Corp., AC Spark Plug Div.,** Milwaukee, Wis., for work on an inertial guidance system.

$6,000,0000—**Defense Electronics, Inc.,** Rockville, Md., for equipment for the Atlantic Missile Range.

$3,600,000—**General Dynamics Corp., Astronautics Div.,** San Diego, Calif., for advanced research and development on ballistic re-entry system.

$1,500,000—**Geotechnical Corp.,** Garland, Tex., for further work on Vela-Uniform program of detecting underground nuclear explosions.

$1,028,557—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for synthesis of high-energy rocket fuels, and performance and durability demonstration of a flight-weight thrust chamber assembly using a high-energy storable propellant combination.

$1,000,000—**Aerojet-General Corp.,** Azusa, Calif., for research work on large rocket motor casings.

$642,743—**Motorola, Inc.,** Riverside, Calif., for microwave transmission system extension.

$398,117—**E. I. du Pont de Nemours & Co.,** Wilmington, Del., for synthesis of high-energy solid oxidizer binder propellants.

$278,680—**Lockheed Propulsion Co.,** Redlands, Calif., for hybrid propulsion system and high-expansion ratio rocket engine nozzle studies.

$211,983—**Aerojet-General Corp.,** Sacramento, Calif., for study of high chamber pressure rocketry with high-energy storable liquid propellants.

$173,443—**Rocket Research Corp.,** Seattle, for high-energy pulse throttled micro-thrust rocket engine.

$61,185—**Gallery Chemical Co.,** Gallery, Pa., for high-energy oxidizer chemistry.

$44,975—**Martin Marietta Corp.,** Baltimore, Md., for lunar mission simulator trainer rental.

$26,175—**Plas-Tech Equipment Corp.,** Natick, Mass., for universal tester.

ARMY

$18,800,000—**Western Electric Co.,** Whippany, N. J., for design, development and fabrication of a multifunction radar device for *Nike X.*

(Continued on page 57)

THE DISCONTENTED MEN "To be discontented with the divine discontent…" These words of Charles Kingsley describe a frame of mind most often found in the men of research.

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On May 20, American Aviation Publications, Inc., the publishers of the Aviation DAILY and MISSILES AND ROCKETS, published the first issue of the MISSILE/SPACE DAILY. It is a factual news service designed to bring you accurate and comprehensive industrial and governmental reports every twenty-four hours.

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Contracts/Procurements

(Continued from page 52)

$5,739,146—**General Dynamics/Pomona,** Pomona, Calif., for continued development of the *Redeye* missile.

$4,200,000—**Sylvania Electric Products, Inc., Electronic Defense Laboratories Div.,** Mountain View, Calif., for electronic warfare research and development.

$2,850,000—**Hughes Aircraft Co.,** Culver City, Calif., for research and development on the *TOW* missile.

$2,230,139—**Intercontinental Manufacturing Co.,** Garland, Tex., for production of *Pershing* missile cases.

$2,000,000—**Sperry Rand Corp., Sperry Utah Co.,** Salt Lake City, Utah, for launcher, general support, equipment and services for the *Sergeant* missile system (10 contracts).

$196,000—**Hughes Aircraft Co.,** Culver City, Calif., for hardpoint systems study associated with *Sprint* and *Nike-X* weapon systems.

$200,000—**Sperry Gyroscope Co.,** Great Neck, N. Y., for a design plan for the ground link equipment in a military communications satellite program.

$52,500—**General Dynamics Corp.,** Pomona, Calif., Div., for continued research and development on the *Mauler* weapon system.

NAVY

$23,000,000—**Bendix Corp.,** Mishawaka, Ind., for continued production of the *Talos* missile.

$21,900,000—**General Dynamics Corp.,** Pomona, Calif., Div., for guidance and control equipment for the *Terrier* and *Tartar* missile weapon systems.

$3,500,000—**North American Aviation, Inc., Rocketdyne-McGregor Div.,** McGregor, Tex., for work on *Sparrow III* missile motors.

$2,800,000—**Interstate Electronics Corp.,** Anaheim, Calif., for engineering services related to the FBM (fleet ballistic missile) program.

$2,100,000—**Babcock Electronics Corp.,** Costa Mesa, Calif., for command/control transmitting systems.

$1,489,650—**Vitro Laboratories,** Silver Spring, Md., for engineering services on the *Typhon* missile system.

$1,232,400—**Philco Corp.,** Philadelphia, for production of guidance control sections for *Sidewinder* air-to-air missiles.

$1,193,780—**Aerojet-General Corp.,** Azusa, Calif., for production of rocket motors.

$1,193,780—**Bermite Powder Co.,** Saugus, Calif., for rocket motors.

$1,000,000—**Vitro Laboratories,** Silver Spring, Md., for engineering services on the *Polaris* fleet ballistic missile system in 1963.

NASA

$2,500,000—**Lear Siegler, Inc.,** Anaheim, Calif., for instrumentation equipment.

$600,000—**Aerojet-General Corp.,** Sacramento, Calif., for further work on the M-1 liquid hydrogen engine.

$556,000—**North American Aviation, Inc., Space and Information Systems Div.,** Los Angeles, for one-tenth scale dynamic models of the *Saturn V* booster.

$323,000—**American Machine and Foundry Co.,** Alexandria, Va., for prototype and flight units of a solar spectrometer experiment.

$277,900—**Bisset-Berman Corp.,** Santa Monica, Calif., for study of abort procedures for *Apollo* lunar landing and reconnaissance.

$199,000—**General Electric Co.,** Philadelphia, for study of dynamics and static seals for liquid rocket engines.

$150,000—**Westinghouse Electric Corp., Astronuclear Laboratory,** Pittsburgh, for a one-year study of potential physiological radiation damage in space.

$143,600—**Hughes Aircraft Co.,** Malibu, Calif., for re-design, development and fabrication of four flight-rated power supplies for SERT-1 test.

$140,000—**Itek Corp., Vidya Div.,** Palo Alto, Calif., for study of existing re-entry flight data.

$100,000—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for manned Mars landing and return mission study.

$94,000—**Itek Corp., Vidya Div.,** Palo Alto, Calif., for analysis and experimental study of rocket engine ablation material.

$94,000—**Northrop Corp.,** Ventura, Calif., Div., for study of retro-rocket parachute system.

$66,100—**Lear Siegler, Inc.,** Anaheim, Calif., for missile-borne television system.

Whirlpool Corp., Systems Div., Benton Harbor, Mich., for the development of a personal hygiene system for Project *Gemini* (undisclosed amount).

Melpar, Inc., Falls Church, Va., for laboratory research on cometary materials and properties (undisclosed amount).

Perkin-Elmer Corp., Norwalk, Conn., for development of a unique new miniaturized carbon dioxide sensor for monitoring manned space vehicle cabin atmospheres by infrared methods (undisclosed amount).

INDUSTRY

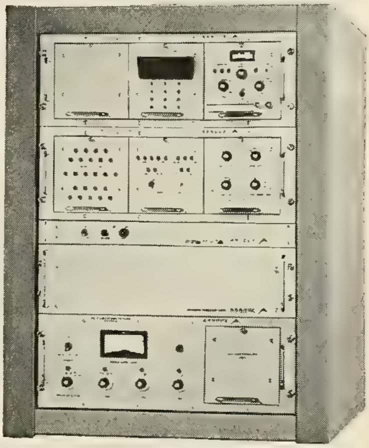
$1,000,000—**Lear Siegler, Inc.,** Santa Monica, Calif., from **Sperry Utah Co.,** for guidance fin servos for the *Sergeant* missile.

$300,000—**Allegany Instrument Co.,** Cumberland, Md., from **United Technology Center Div. of United Aircraft Corp.,** for a substantial quantity of Mark X flexures.

$300,000—**Consolidated Systems Corp.,** Monrovia, Calif., from **United Technology Center,** for an analog and digital data processing system to process rocket motor test data and computer analysis.

$201,000—**Electric Storage Battery Co., Missile Battery Div.,** Raleigh, N. C., from **Martin Co.,** for internal power supply batteries for the *Titan III*.

(Continued on page 58)



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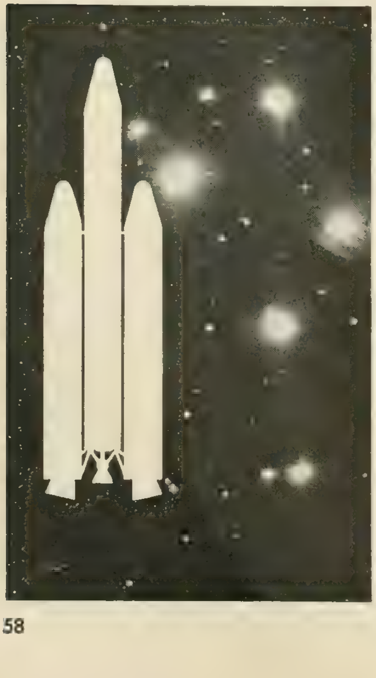

Contracts/Procurements

(Continued from page 57)

$120,000—**Ryan Aeronautical Co.,** San Diego, from **Boeing Co.,** for components of the interstage assembly of the *Minuteman* weapon system.

$67,400—**Eagle Picher Co.,** Joplin, Mo., from **Martin Co.,** for *Titan III* destruct system batteries.

Stanford Research Institute, Menlo Park, Calif., from **North American Aviation's Space Div.,** for development of food for astronauts in Project *Apollo.*

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

General Support Div.
Directorate of Procurement and Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

Synopsis covers additional research and development effort for the *Redeye* missile system. Work will be performed at General Dynamics/Pomona, Pomona, Calif., during the period May 1963 through Sept. 1963. Non-availability of drawings and specs, duplication of initial investment in special tooling and facilities, plus the requirement for technical know-how precludes award to other than above named contractor. All inquiries relating to subcontracting opportunities should be referred to General Dynamics/Pomona.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

Reconnaissance systems study for manned lunar missions as a means of obtaining lunar surface environmental data and mapping imagery—1 study. Delivery to NASA, Manned Spacecraft Center, Houston 1, Tex. RFP MSC 63-627P. RFP due date 6-7-63.

Systems study for lunar reconnaissance probes. Requirements include defining an unmanned lunar surface probe to be deployed from lunar orbit to obtain soils, mechanics data and reconnoiter the lunar surface—1 study. Deliver to NASA, Manned Spacecraft Center, Houston 1, Tex. RFP MSC 63-627P. RFP due date 6-7-63.

National Aeronautics and Space Administration
Contracts Div.
Washington 25, D. C.

The National Aeronautics and Space Administration proposes to contract for the furnishing of 37 each ⅛ scale fibre glass models of the *Nimbus, Ranger, Surveyor* and *Orbiting Geophysical Observatory* space satellites. Copies of the invitation for bids will be furnished on a first come, first served basis.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

NASA solicits proposal for recorder, true RMS level, B&K Instruments, Inc., No. 2305A or approved equal. A strip chart recorder for accurate recording of the true RMS average, or peak level of AC signals ranging in frequency from 10 CPS to 200,000 CPS and DC to 10 CPS signals through an internal chopper—5 each. IFB CC-276-3.

Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

KNB 64-9D. Technical area for missile and space vehicle lubrication. To conduct research which will provide lubricants and lubrication techniques that can be utilized in missile and space vehicle propulsion systems and flight vehicle power systems. The expected result is providing lubricants and lubrication techniques that can endure the severe conditions prevalent in these systems without altering the performance objective of these systems. Missiles and space vehicle flight power equipment impose conditions of high vacuum, zero gravity, nuclear radiation and corrosive liquid and metal vapor environments in addition to extreme temperature conditions.

National Aeronautics and Space Administration
Contracts Headquarters
Washington 25, D. C.

The National Aeronautics and Space Administration is negotiating a contract with National Research Corp., Cambridge, Mass., for a study of adhesion and cohesion of metals in ultrahigh vacuum. This is a result of an unsolicited proposal. This notice is for information only.

The National Aeronautics and Space Administration is negotiating a contract with Astronautics Div. of Chance Vought Corp., Dallas, Tex., for a remote man-machine control system evaluation. This action is the result of an unsolicited proposal. This notice is for information only.

The National Aeronautics and Space Administration is negotiating a contract with the Physics Research Div. of Geophysics Corp. of America, Bedford, Mass., for a study of the meteorology of Mars and Venus. This proposed work is a result of an unsolicited proposal. This announcement is for information only.

Directorate
Procurement and Production
Air Training Command
Randolph Air Force Base, Tex.

Three additional classes in course Acc. 31272G-7, system analyst, SM-80. Job—RFP CH-CT-64-15. RFP due date 6-4-63. Course covers depot overhaul and maintenance of the *Minuteman* (SM-80) inertial guidance system. This is second follow-on of training presently being conducted by Autonetics Div., North American Aviation, Inc., Anaheim, Calif., under contract AF 41(689)-738. Training will be conducted at Autonetics Div. facilities from 7-17-63 to 12-31-63. Source of students is Air Force Logistics Command. Three classes, 15 students total. Request for proposal has been issued only to Autonetics Div., North American Aviation. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with above firm.

National Aeronautics and Space Administration
Wallops Station
Wallops Island, Va.

Service and materials for horizontal static and dynamic balancing system. RFP P-673. RFP due date 6-24-63.

Office of Procurement and Contracts
George C. Marshall Space Flight Center
Huntsville, Ala.

Three items of Dewars. Lot—IFB MSFC-63-371. Bid opening 6-4-63.

U. S. Army Missile Command
Directorate of Procurement and Production
GOCO Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXG

Selected source procurement for Thiokol Chemical Corp., Alpha Div., Huntsville Plant, Huntsville, Ala., for the manufacture and delivery of one XM33E6 pollux solid propellant rocket motor. This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor. No proposals are available.

Hercules Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure from Revere Corp. of America services in connection with cable assemblies to check out the *Nike-Hercules* launcher circuitry. This synopsis is to publicize possible subcontracting opportunities and all inquiries relative to subcontracting must be referred to Revere Corp. of America, Wallingford, Conn.

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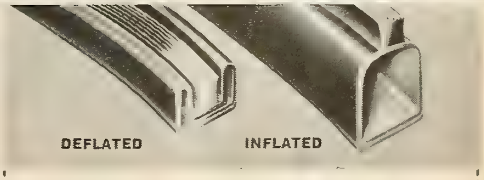
BFG makes an inflatable seal that works much the same as this little gizmo. It pops up instantly with a little inflation, snaps back when pressure is released. Big advantage of the inflatable seal is that it gives you a firm, pressure-tight seal . . . yet provides very wide learance when deflated for quick, easy access. It's used to seal blast loors, pressurized canopies, radiation chambers, explosive areas, quipment on amphibious vehicles. Provides an atmospheric seal, eeps out gases, dirt, fluids. These BFG seals come in any length, n several cross-section sizes. Can be installed mechanically or with dhesives, in straight runs, around corners. Does this give you an lea? Send coupon for Design Guide.



Mail coupon for BFG Inflatable Seal Design Guide

The B.F.Goodrich Company
Aerospace and Defense Products, Dept. MR-5
500 South Main Street, Akron 18, Ohio

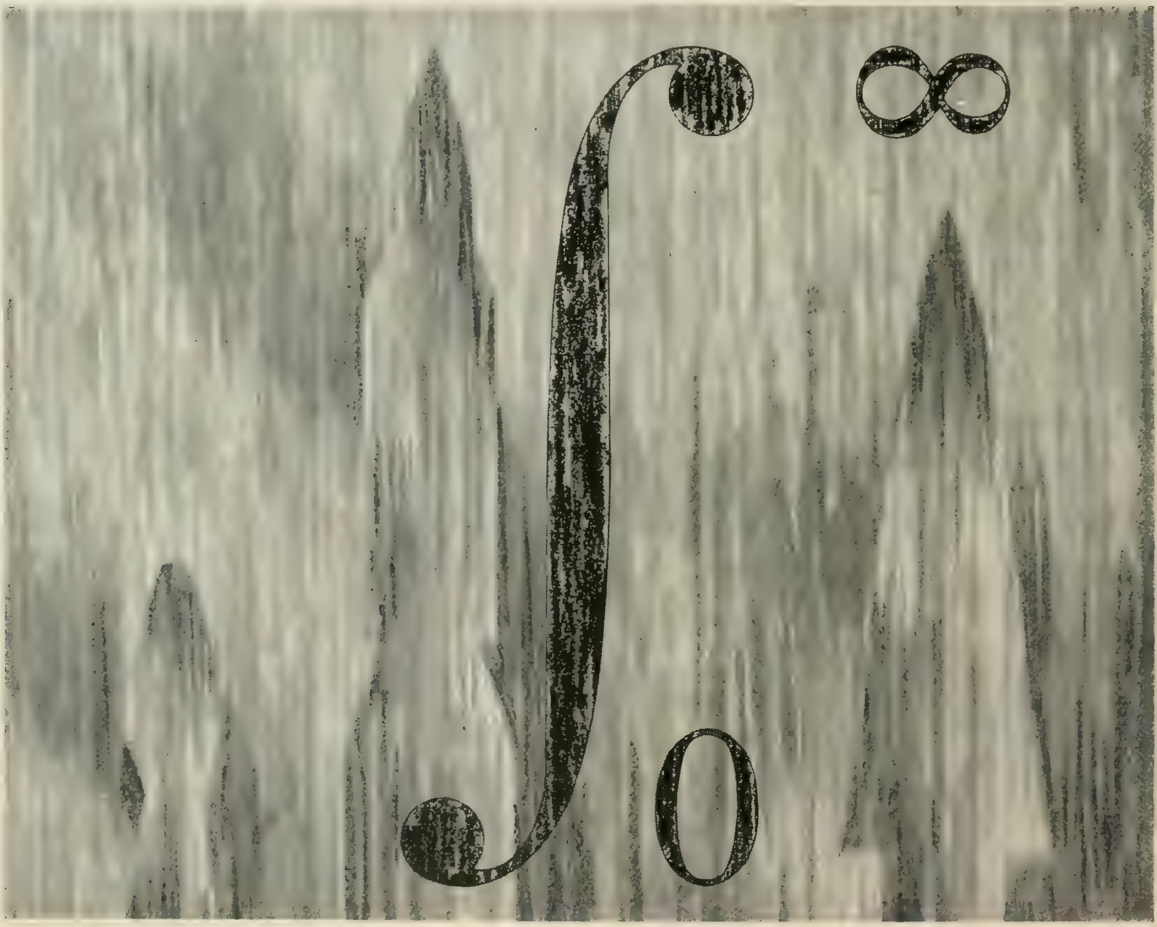
Your Name____________________Title__________
Company______________________________
Address______________________________
City____________________State__________

Circle No. 15 on Subscriber Service Card

MATHEMATICAL MISSILES

...AND WHAT DOUGLAS IS DOING WITH THEM

Aerospace planners find themselves with a number of potential vehicle designs for any given mission. To avoid the multimillion dollar expenditures testing even a few of these would entail, industry has devised mathematical procedures that do the big job of weeding out the poorer designs. □ Douglas missile and space system mathematical simulation programs are among the most advanced and comprehensive in operation today. The company's researchers have developed a variety of procedures that "flight test" hypersonic vehicles in the laboratory..."expose" configurations to intense heating and loading environments...even conduct "battles" between missiles. Another aid is a unique Douglas viewing system which allows relationships between various parameters (trajectories, et cetera) to be observed in three dimensions.



Advanced mathematical short-cuts to better aerospace systems are among the numerous research programs in 23 broad technological areas now under way at Douglas. Major Douglas Divisions are located in Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

DOUGLAS

New Product of the Week: Surface-Measuring Microscope

Carl Zeiss, Inc., has available an instrument capable of measuring surface roughness non-destructively with an accuracy of 0.000040 inch.

The Light-Section Microscope can also measure thickness of transparent films and foils, depth of etchings, and small parts such as suspension wedges and pans of balances which cannot be measured by the usual projection or silhouette methods. Measurements are made without touching the surface of the sample.

A thin, razor-like band of light is projected at a 45-degree angle upon the surface to be inspected. This band of light, which traces out the profile of the surface, is viewed at a 90° angle through the microscope. Roughness is measured by moving a reticle to the peaks and valleys of the profile. The difference is read in microns.

Circle No. 225 on Subscriber Service Card

Vibration Damping

B&K Instruments, Inc. is marketing the Model 3930 Complex Modulus Apparatus and associated instrumentation for measurement of internal damping and dynamic elasticity of solid materials.

The internal damping of a solid material can be determined from measurements made on a sample bar clamped in the apparatus and excited at one of its resonant frequencies. At resonance, the vibration amplitude is limited by the mechanical internal damping of the sample.

The unit can also be used to determine the dynamic modulus of elasticity of a sample. With the damping factor and the modulus of elasticity determined, the complex modulus of elasticity can be established. The measurements are also useful in research into the molecular structure of materials.

Circle No. 226 on Subscriber Service Card

Servovalve Test System

The Aerospace Division of Vickers Inc., Division of Sperry Rand Corp., is marketing a universal system for testing electrohydraulic servovalves and related equipment. Complete instrumentation is provided for a wide range of servo component testing. Static and dynamic testing can be conducted individually or simultaneously with two parallel circuits in the hydraulic power supply. Separate static and dynamic test consoles are provided.

The X-Y recorder permits completely automatic plotting of all static test data. Completely integrated control is provided for reversing signal polarity and reversing signals to the X-Y recorder. Sinewave, square or triangular waveform valve cycling is possible down to 0.008 cps. Sum and differential current accuracy is within ±½ percent of full scale.

The hydraulic power supply includes all necessary valves, gauges and associated circuitry. Automatic temperature controls working in conjunction with built-in heaters and coolers permit high or low temperature testing with either circuit. Flow up to 10 gpm is provided by a Vickers variable-displacement pump. Manifolded valve mounting pads are provided on the front of the stand.

Circle No. 227 on Subscriber Service Card

Time Delay Relay

A low-cost, long-life, time delay relay, featuring extended time ranges and permitting a change of timing settings during operation, has been developed by the Cramer Division, Giannini Controls Corp.

The extreme accuracy and long life of the new Cramer model, designated Type 450, make it applicable to a wide range of industrial uses. With only 7 moving parts, the unit's simplicity guarantees its ruggedness. The expected mechanical life of the unit is 3,000,000 operations; its repeat accuracy is 0.2% or 1/10 second, whichever is greater. The extended time range covers 12 seconds to 30 hours.

Model 450 incorporates one or two SPDT load switches. A clutching solenoid, internally wired to two external terminals, actuates the timing mechanism. One or two SPDT instantaneous clutching switches can be incorporated, which transfer only when the state of the solenoid is changed.

The Cramer relay provides an adjustable time delay between the closing of a control unit and the opening or closing of one or two independent load circuits. Fast and simple setting of the time interval is manual.

Circle No. 228 on Subscriber Service Card

Modular Pressure Scanner

Scanivalve Co. has available modular pressure scanners claimed to measure 576 separate pressures up to 50 psia. A single motor or solenoid drive unit powers from 1 to 12 modules. In each module an integral standard ½-in.-dia. flush diaphragm pressure transducer is said to do the work of up to 48 external transducers.

Circle No. 229 on Subscriber Service Card

Solid-State Relay

Solid State Electronics Co. has available SSR-1285-5050 solid-state relay, a silicon transistorized static switching relay with no moving parts. Actuation time is 2 microseconds and dropout time is 5 microseconds. Actuation frequency can be as high as 50 kcps. The contacts are rated at 50 volts, 50 milliamperes.

The utilization of silicon semiconductors provides for reliable operation over a temperature range extending from −55° to 125°C.

Circle No. 230 on Subscriber Service Card

Transistor Headers

A series of metalized ceramic transistor headers is being marketed by Metalized Ceramic Corp.

Standard packages contain TO-5 and TO-18-46 transistors. The ceramic is 94% alumina with flanges available in Kovar or OFHC copper. Leads are supplied in either Kovar or copper-cored #52 alloy material. The products are described in bulletin M-405 available from the company.

Circle No. 231 on Subscriber Service Card

COMMAND AND CONTROL—AFTER ATTACK

Another challenging new assignment at MITRE

Today at MITRE, engineers and scientists are needed to help turn national defense policy into engineering reality. The Air Force has recently assigned MITRE the task of being the system engineer for the PACCS program, the Post Attack Command and Control System. This system is to enable the Commander-in-Chief, Strategic Air Command to improve control of his forces in the event that a nuclear attack destroys or seriously degrades his normal facilities. To accomplish the role of system engineer and to provide technical support, computer people are now needed to help design the system; to write subsystems specifications; and to carry the system through advanced development stages. At MITRE — the job is to design and direct development of the Post Attack Command and Control System (481L), test it, make it work.

PACCS is just one of four important new assignments that have recently come to MITRE's rapidly expanding scientific community in Greater Boston. Others include the fulfillment of a new aerospace communications program and a nuclear detection and reporting system.

Minimum requirements, B.S., or M.S., or Ph.D. in these disciplines: electronics, physics, and mathematics. MITRE is located in pleasant, suburban Boston. Rewards are competitive. Write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, P. O. Box 208 G, Bedford, Mass.

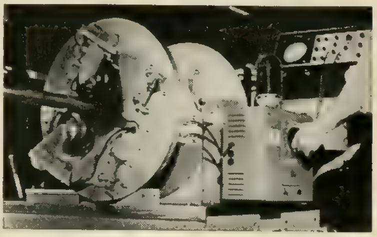
THE
MITRE
CORPORATION
An Equal Opportunity Employer

Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.

'Whirling Dervish'

Sperry Products has available a testing system, the "Ultrasonic Whirling Dervish," designed to test rounds or tubing at high production speeds.

The device rotates the multiple Search Unit Wheel arrangement around the bar or tubing, scanning the piece for internal flaws as it passes through the inspection station. The presence of a discontinuity of predetermined size is automatically signalled, recorded and the piece marked for reject or for further investigation.



The UM 700 is a basic testing instrument which, through selection from a line of interchangeable plug-in units, provides combinations from simple manual testing instruments to complex multifunction arrangements.

Circle No. 232 on Subscriber Service Card

Quantity Transmitter

The Chronoflo® Electrical Quantity Transmitter available from B-I-F Industries increases the scope of applications and provides greater flexibility by using interchangeable plug-in circuit cards. The redesigned module, which mounts in a single position, includes a sweep section, electronic switch and power supply for totalizer and/or power positioner clutches.

Applications for the new unit include summation of flows by adding resistances, telemetering position of potentiometers and converting dc voltage or current output from transducers, pH, ORP, turbidity, chlorine residual or density measuring instruments into time-impulse signals.

Circle No. 233 on Subscriber Service Card

High Torque Motor

Electric Indicator Corp. is marketing two ⅓-hp., 3600-rpm hysteresis-synchronous motors, claimed to produce 100 oz-in of torque while measuring only 4⅜-in. dia. by $8\frac{13}{16}$-in. overall.

Model GLXH-1749 is for 115 volt 60 cycle 1 phase, and Model GLXH-1767 for 208 volt 60 cycle 3 phase.

Both units are designed to mil specs and incorporate ball bearings for maintenance-free operation.

Circle No. 234 on Subscriber Service Card

Telegraph Repeater

A universal 4-channel telegraph regenerative repeater, that automatically discriminates between "start-stop" and synchronous modes, has been developed by Ortronix, Inc. The unit, which is compatible with any type transmission, restores original generated signal to within 1%, when the signal has deteriorated as much as 45%.

Designated "Model 1909A," the repeater automatically receives and regenerates 61.12 baud synchronous and 74.2 baud "start-stop" signals in the 100 wpm position. In the 60 wpm position the repeater regenerates 37.5 baud synchronous and 45.45 baud "start-stop" signals. The circuit accepts 20 or 60 mil current pulses and provides proper filtering and signal reconstruction consistent with extreme noise and distorted input signals. Output from the signal conditioner has a rise and fall time of less than one microsecond.

Circle No. 235 on Subscriber Service Card

Vibration Transducers

A high-temperature, linear vibration transducer which operates effectively above 34 cps and between −65°F and 700°F has been introduced by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.

The transducer is a permanent magnet voltage generator which operates on the seismic mass principle with coulomb damping. It can be used without change in calibration with any ac voltage-measuring device presenting a 10,000 ohm resistive load impedance to the transducer. Low transverse response permits the unit to be mounted in any direction.

Circle No. 236 on Subscriber Service Card

Vacuum Gauge

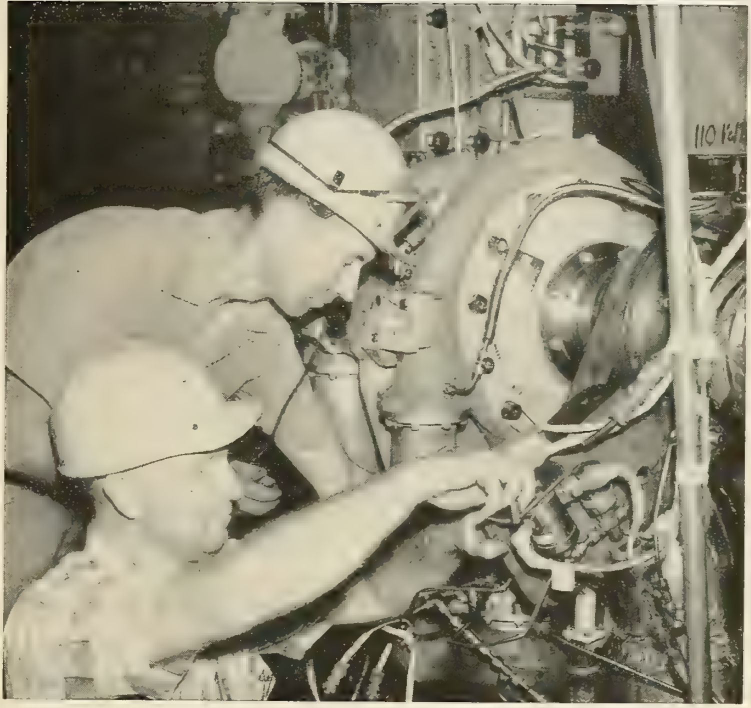
An ultra-stable vacuum ionization gauge, the GIC-200 is available from Consolidated Vacuum Corp. for reading pressures from 2×10^{-10} to 1×10^{-8} torr. A plug-in thermocouple accessory extends the range to 2 torr.

The GIC-200 features a long-life, dual-filament sensing tube which can be switched to the spare filament without breaking vacuum. The filaments are spring-loaded to allow tube mounting in any position. The tube is bakeable to 450°C and a switch-selected filament booster voltage helps to extend tube life.

A built in filament protection circuit is adjustable from 1½ to 2 times full scale. It operates a pilot light which indicates filament deactivation. Automatic filament emission control provides unusual stability.

Circle No. 237 on Subscriber Service Card

Taber® TELE·NEWS
ABOUT TELEDYNE AND TELEFLIGHT PRESSURE SYSTEMS



Taber Transducer checks LOX injector pressure on Atlas engine at Rocketdyne

Hot firing of all engines to make sure they're up to Air Force specifications is standard procedure at Rocketdyne, a division of North American Aviation, Inc. As this Atlas Booster engine is readied for testing, attention focuses on the Taber Bonded Strain Gage Pressure Transducer used to measure gas generator LOX injector pressure.

Taber Transducers are ideally suited for checking pressures such as this, as well as for numerous other laboratory, industrial, ground support and airborne applications. A wide variety of models is available in pressure ranges from 0-50 to 0-10,000 psi. Among the many features which contribute to rugged, dependable performance are: high frequency response, minimum hysteresis, infinite resolution and low sensitivity to temperature effects, vibration and shock.

For more detailed and illustrated information, attach this coupon to your letterhead and mail.

TO: TABER INSTRUMENT CORPORATION
AEROSPACE ELECTRONICS DIVISION SECTION 851
107 Goundry Street, North Tonawanda, N. Y.

Send detailed information on Taber Teledyne and Teleflight bonded strain gage pressure transducers.

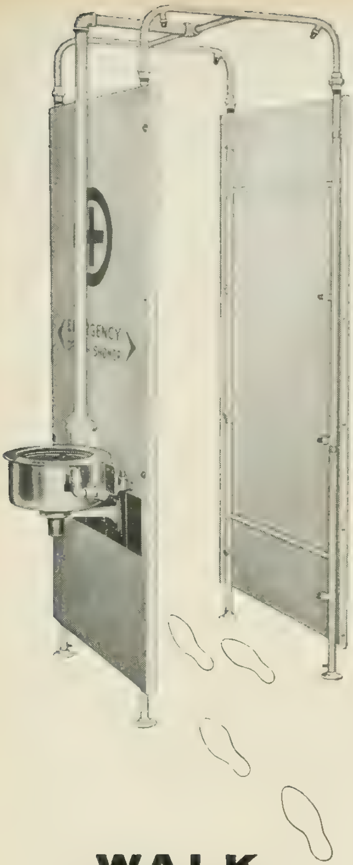
name ____________ title ____________

company ____________ dept. ____________

address ____________

city ____________ zone ______ state ____________

Circle No. 17 on Subscriber Service Card



WALK THROUGH to SAFETY

HAWS

DECONTAMINATION SHOWER model 8562

Ready for action! 16-FULLJET nozzles drench the body when large Push-Type instant-action ball valve is opened. Here is the *instant* first aid so vital to countering body contamination. A Haws stainless steel (Model 7900-B) eye/face-wash is mounted on paneled side to provide a complete "one-stop" safety station. Functional parts are rugged red brass. Write for detailed specs: *Haws Drinking Faucet Company, 1443 Fourth St., Berkeley 10, California.*

HAWS Since 1909

EMERGENCY EQUIPMENT

Circle No. 18 on Subscriber Service Card

Frequency Measurement

Interchangeable plug-in modules, converting both function and range, permit an entire line of solid state counting, timing and frequency measurement instruments on a single basic chassis being marketed by Computer Measurement Co.

The chassis contains the power supply, oscillator, and 8-digit NIXIE display with memory and related circuitry. Two range modules, dc to 25 mc and dc to 50 mc, are currently available. Function modules for frequency measurements with gate times from 1 μsec to 100 seconds, for period measurements from single period to 10^8 periods up to 10 mc, or for time interval measurements from 0.1 μsec to 10^8 seconds are also in production.

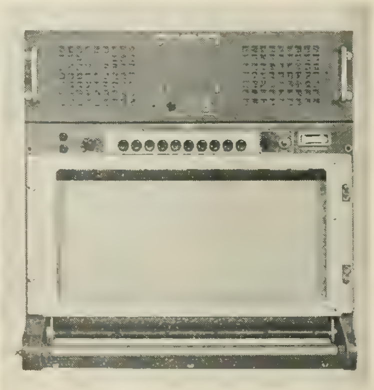
Under final development are interchangeable function modules to provide direct counting to 200 mc, time interval measurements to 10 nanoseconds, heterodyning to more than 1 gc, a digitally controlled oscillator, voltage and frequency scanners, variable time base, digital Q meter, phase meter and voltmeter.

Circle No. 238 on Subscriber Service Card

Event-Recording System

A Series 360 event-recording system instantly records 120 channels of on/off information on a 16-in., dry, electrically sensitive chart providing a permanent record or duration and relative timing of events. Response to events as brief as 1.3 milliseconds is made possible by the Sanborn Model 360-2100 writing control which is connected to the recorder by four plug-in cables.

Produced by the Industrial Division, Sanborn Company, the recorder uses "pulsed writing" technique which prolongs stylus life and produces sharp, clear traces at any of the 18 chart speeds. Each bank of 30 styli may be pulled out and an individual stylus replaced.



Circle No. 239 on Subscriber Service Card

Miniaturized Converter

Two miniaturized instrumentation accessory units, a converter and a regulator, for airborne and ground applications using microminiature differential amplifiers, have been developed by the Electronics Division of Baldwin-Lima-Hamilton Corp.

The BLH Model 710 dc-to-dc converter provides power supply isolation in applications where various types of grounds exist in the system.

The BLH Model 720 dc regulator affords a high-performance regulated supply of dc power in systems where an unregulated source is used.

Circle No. 240 on Subscriber Service Card

High-Pressure Transducer

Now in production at Micro Systems, Inc., is a miniature, high-pressure transducer for applications ranging from wind tunnel research to hydraulics instrumentation.

The Model PT 3C-B1 is available with ranges from 0-50 to 0-5,000 psia and weighing less than 0.3 ounce. Its solid-state elements are bonded to the back of a pressure sensing diaphragm and are wired to a full-bridge circuit to convert pressure-induced strains to a high-level electrical output (0.5vdc$+10$ -0% full scale at 78°F). Built for reliable operation over an ambient temperature range of −65° to 300°F, it is said to withstand overpressure of 300% minimum.

Circle No. 241 on Subscriber Service Card

Digital Logic Elements

Tech Serv, Inc., has available a line of transistorized digital logic elements.

The FPP line of DigiBits offers the convenience of plug-in logic modules with the reliability of solid state circuitry. In the FPP line all input and output connections are made on the front panel which is imprinted with the appropriate logic symbol and color coded to make package identification easier.

Each module has 4 dual-purpose plugs which enable it to be simply and effectively mounted in the module case. All power connections are automatically made when the elements are plugged in.

Circle No. 242 on Subscriber Service Card

CAREER NEWS FROM HUGHES

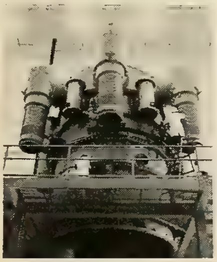
Aerospace Divisions in Culver City, California

NEW AND CONTINUING PROGRAMS AND PROJECTS

TFX(N) Guided Missile System
MMRBM (Integration, Assembly and Checkout)
SURVEYOR Lunar Landing Vehicle
SYNCOM Synchronous Communications Satellite
POLARIS Guidance
TOW Anti-tank Missile
ARPAT
VATE Automatic Checkout System
FALCON Missiles
HARD POINT DEFENSE

These examples of Hughes Aerospace activities are representative of *more than* 230 major product and service capabilities ranging from aerospace vehicles to ASW systems.

OUTSTANDING TECHNICAL FACILITIES

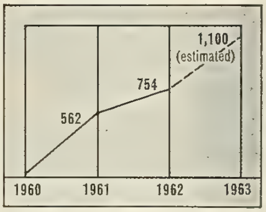


This giant environmental test chamber at Hughes new Space Simulation Laboratory is just one of a complete range of facilities maintained by the company for the Technical Staff. Hughes physical plant and professional atmosphere, unexcelled in industry, encourage individual achievement.

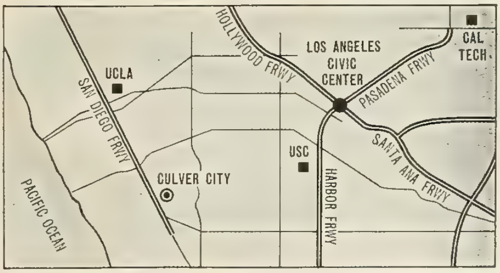
GROWTH OF THE TECHNICAL STAFF

Of the nearly 9,000 employees of these divisions, 2,600 are Members of the Technical Staff. Average length of experience is 10.0 years. Average age is 32 years.

ADDITIONS TO TECHNICAL STAFF



HUGHES/CULVER CITY & LOS ANGELES



Hughes Aerospace Divisions at Culver City offer engineers and scientists a unique combination of urban and suburban advantages. The plant is immediately adjacent to a major freeway. Los Angeles Civic Center is about a half-hour distant. Beach communities are just minutes away. Attractive residential neighborhoods are nearby. UCLA, USC and Cal Tech offer outstanding educational facilities.

IMPORTANT OPPORTUNITIES, steady growth, advanced facilities, fine living conditions—these are the advantages which Hughes Aerospace Divisions can offer you at Culver City.

Requirements include an accredited degree in E.E. or M.E. and specialized experience which can be related to development of aerospace vehicles. U.S. citizenship required.

For immediate consideration please airmail your resume *today*. We promise you a reply within one week.

MR. ROBERT A. MARTIN
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City, 15, California

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS
An equal opportunity employer

Spectrum Analyzer

Multiple simultaneous outputs prevent data loss in a laboratory parallel filter spectrum analyzer system offered by Gulton Industries.

The unit provides 31 filtered outputs in both parallel and serial form and constant simultaneous surveillance of all frequencies of interest is maintained. The analyzer accepts sine wave, periodic complex and random signals and allows for real-time data reduction. Fully automatic, the system reduces reduction time in ground support or laboratory studies of vibration, sound, stress and fatigue.

The scanner section is all-electronic and the entire system utilizes conservatively operated components for long life and maintenance-free operation. Versatile design and modular construction make expansion easy.

Circle No. 243 on Subscriber Service Card

Automatic Cable Tester

An automatic cable tester which measures insulation resistance, dielectric strength, and continuity, with high speed and accuracy, is available from Accurate Electronics Corp. The unit tests simple and complex cable assemblies, bulk cable, harness assemblies, and connectors, at speeds which permit low cost operation.

The device checks insulation resistance from 1 to 5000 megohms, dielectric strength from 0 to 3000 volts, ac or dc, continuity resistance from 0.5 to 50 ohms, and continuity current from 0.1 to 2 amps. High speed testing can be accomplished at a rate of 120 circuits per minute.

Multiple circuits are automatically sensed and tested without additional programming, and the design features further simplify checking of complex branch circuitry. No patchboard or jumper plugs are needed, reducing setup time.

Circle No. 244 on Subscriber Service Card

Hyperthermal Tunnel

A laboratory model arc heated hyperthermal tunnel simulating re-entry conditions of temperature and densities is available from Plasmadyne Corp. a subsidiary of Giannini Scientific Co.

Priced within the reach of educational, and smaller research organizations, this tunnel is a scaled-down version of those found in many larger research facilities. It consists of a plasma generator, supersonic nozzle, control console, power supply, test chamber, vacuum pump and piping, and power cable package.

The tunnel is operated using procedures identical to those required for a full-size hyperthermal tunnel. With the vacuum pump running, a sufficient nitrogen gas flow is established through the plasma generator. The power supply is energized and the arc initiated with the auto start system. With the stable jet operating, the desired nitrogen and oxygen flow rates and power input are set.

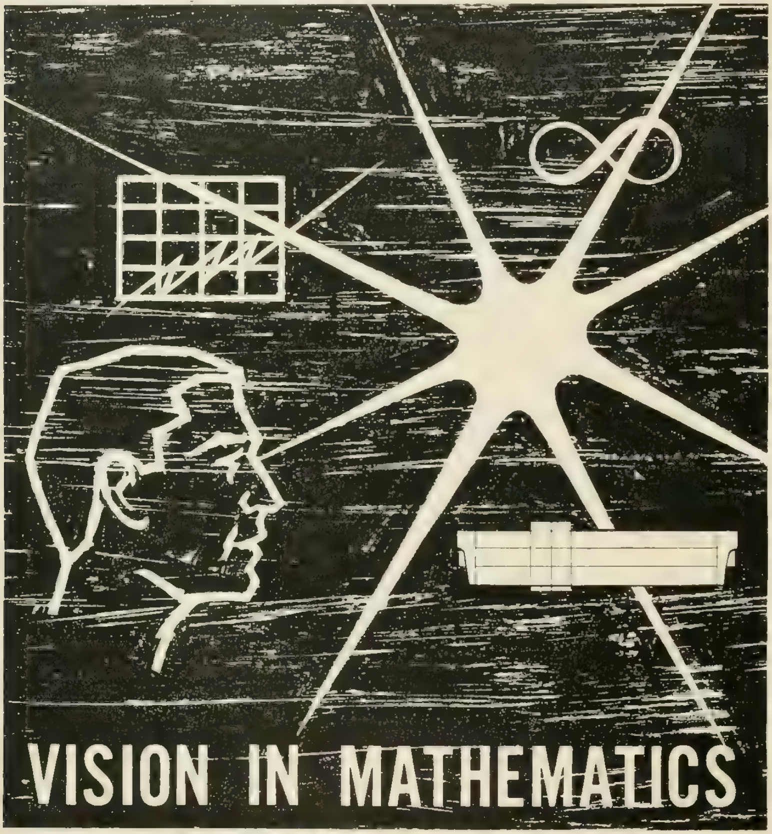
Circle No. 245 on Subscriber Service Card

Cavitation Measurer

An instrument capable of measuring relative cavitation intensity at any point in a liquid is available from International Ultrasonics, Inc. Developed primarily for evaluation and improvement of ultrasonic cleaning operations, the instrument can also reduce to precision measurement the action in other chemical, metallurgical, and biological processes involving ultrasonically-induced cavitation.

The instrument can make accurate determinations of the threshold of cavitation, and of the effects on the threshold and cavitation intensity of such factors as transducer design and location, use of detergents, liquid temperature, and tank design. Because it can take readings at any point in a liquid it can locate hot spots and dead areas

Circle No. 246 on Subscriber Service Card



To support future space exploration programs at Cape Canaveral, RCA seeks additional scientific personnel who approach mathematics with farsighted vision. If your desires and experience are scientific in nature, it will be to your advantage to investigate these opportunities:

MATHEMATICIANS: BS degree plus several years experience in applied mathematics; MS or PhD in mathematics or statistics.

SCIENTISTS...DATA REDUCTION ANALYSTS: BS, MS or PhD degree in mathematics, physics, statistics or related fields. Solve problems concerned with the determination of evaluating accuracy of tracking instrumentation.

PROGRAMMERS: BS degree in mathematics, physics or related fields with experience in scientific programming on large-scale digital computers.

In addition to challenging work, RCA offers an attractive salary, excellent fringe benefits and relocation to FLORIDA.

Address your inquiry to: Mr. H. D. Storz, Employment Manager, RCA Service Company, Dept.N-74C, 750 S. Orlando Avenue, Cocoa Beach, Florida.

An Equal Opportunity Employer

RCA The Most Trusted Name in Electronics

Circle No. 20 on Subscriber Service Card

Look into

Reeves

UNIQUE SYSTEMS CAPABILITIES

Systems project managers can save time and money, and achieve operational hardware faster, by working with Reeves' experienced design and production teams.

Reeves' comprehensive experience in the fields listed has resulted in many pioneer achievements. This experience, combined with extensive, smoothly operating production and test facilities, permits us to take on major assignments.

A review of what Reeves has done, is doing, and can do, will demonstrate the unique character of our capabilities . . . for systems, subsystems, assembly and component development, engineering, production, supply and field service. Data file 505 on request.

FOR EXAMPLE: TRACKING RADAR SYSTEMS

Reeves' achievements in tracking radar cover a broad spectrum. In the long range field, Reeves Verlort® . . . Very Long Range Tracking Radar . . . is among the most accurate systems available. Field-proven in satellite programs, Verlort installations perform consistently at ranges of 5,000 miles and better.

Another unusual Reeves' development, the Radar Bomb Scoring Central (AN/MSQ-35), acquires, tracks, and records the flight of aircraft and release of bombs on practice missions. With provision for skin, beacon, and optical tracking, the Central produces continuous plots of aircraft position and bomb trajectory, in horizontal and vertical planes. Maximum range, 100 miles at altitudes up to 300,000 ft.

These complete systems have been designed for compact housing in air-transportable vans for field service. They typify Reeves' comprehensive capabilities for systems' production, from concept to delivery of operational hardware.

Reeves **REEVES INSTRUMENT CORPORATION** *A Subsidiary of Dynamics Corp. of America, Roosevelt Field, Garden City, N. Y.*

Systems *engineering...management...production...field services*

7RV63

William A. Sipprell: Appointed to the newly created position of vice president and general manager of the Lear Jet Corp., Wichita, Kan.

Clarence M. Kowert: Appointed manager of the newly created Flight Systems Dept. of Emerson Electric Manufacturing Co., St. Louis.

John A. Bilka: Joined the Singer Metrics Div. of the Singer Co., Bridgeport, Conn.

Joseph A. Fontana: Named vice president and general manager of West Coast operations for Consolidated Controls Corp., Los Angeles.

Graydon M. Paul: Named manager for the market engineering department of the Lockheed-California Co., Burbank, Calif.

J. L. Brooks: Named manager of research and engineering for sensor products at General Dynamics/Electronics, San Diego, Calif.

Dr. Leonard Bongers: Staff member of the Martin Co.'s Space Systems Div., Baltimore, Md., awarded the 1963 Achievement Award of the Maryland Chapter of the AIAA.

Thomas F. Dixon: Assistant to the president of North American Aviation, Inc., Los Angeles, elected a vice president.

George L. Loomis: Appointed director of operations, Power Equipment Div., Lear-Siegler, Inc., Cleveland.

Kenneth R. Jackson: Named assistant general manager of the Computer Div. of Packard Bell Electronics, Los Angeles.

Hugh C. Land: Appointed vice president-marketing for Pennsalt Chemicals Corp., Philadelphia.

Alfred D. Gronner: Appointed chief engineer for Simmonds Precision Products, Inc., Tarrytown, N. Y.

Thomas F. Maher: Promoted to assistant general manager of the Electronic Systems Div. of Fairchild Stratos, Wyandanch, L. I., N. Y.

Don Fairchilds: Appointed public relations manager of Electro Instruments, Inc., San Diego, Calif.

Elmore Brolin: Appointed general manager of the Electron Products Div. of Marshall Industries, San Marino, Calif.

Bernard L. Friedman: Appointed general manager of Cambridge Div. of Epsco, Inc., Cambridge, Mass.

George T. Dib: Named coordinator of space technology for Vitro-Smith Corp., New York City.

Dr. H. J. Smead: Elected vice president of Teledyne, Inc., Hawthorne, Calif.

Dr. A. P. Lien: Named director of planning in the Chemistry and Chemical Engineering Dept. at Battelle Memorial Institute, Columbus, Ohio.

Steven C. Paton: Appointed director of public relations for Fairchild Stratos Corp., in the Washington, D. C. office.

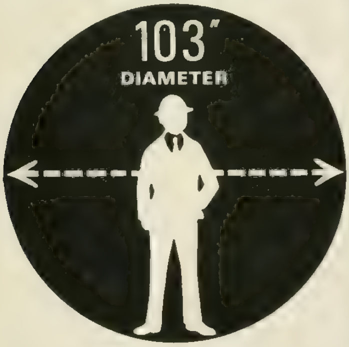
Jerome Pearlman: Appointed vice president in charge of marketing and technical coordination for design and implementation of management systems at Management Systems Corp., Cambridge, Mass.

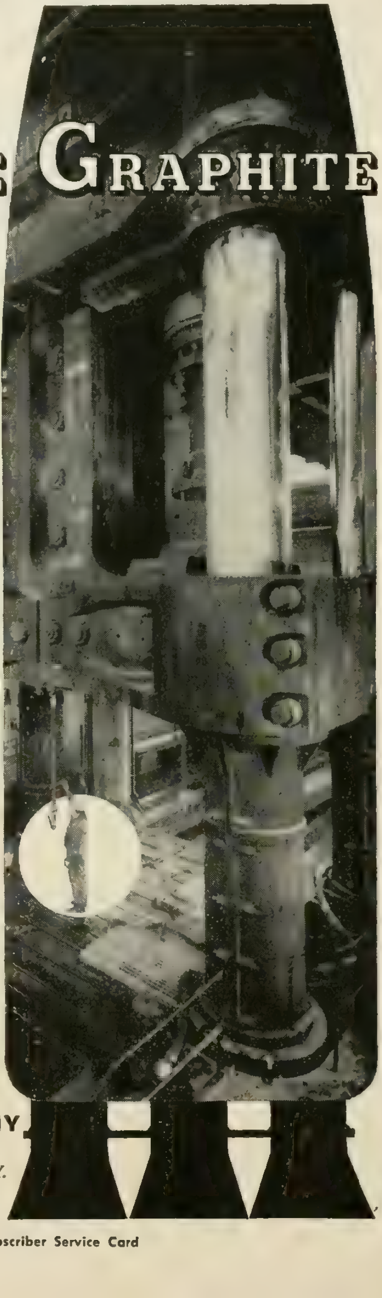
G. A. Hildebrand: Appointed director of marketing at Silicon Transistor Corp., Carle Place, N. Y.

James A. Hill: Joined the Astromechanics Research Div. of Giannini Controls Corp., Berwyn, Pa., as chief of applied dynamics.

James O. Murcklen: Appointed customer requirements manager for ballistic missile programs at Thompson Ramo Wooldridge, Inc.'s Space Technology Laboratories, San Bernardino, Calif.

COMING—
World's Largest
AEROSPACE GRAPHITE





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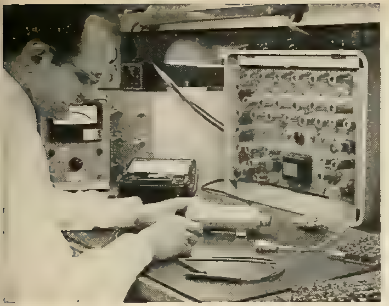

Here, at Lockheed Missiles & Space Company's Space Communications Laboratory, scientists are re-investigating the possibility of using the moon to facilitate earth communications. Possibilities for the use of the moon as a relay station for earth-to-earth communications have been largely neglected because the moon's shape and rugged surface greatly distorted a return signal. But Lockheed research into the extension of communications on difficult communication channels, using techniques applicable to dispersive time variant channels, is making significant inroads into this problem.

Another area receiving intense study at Lockheed is satellite tracking of deep space probes. Since tracking accuracy depends greatly on stations being as far from each other as possible, while retaining line-of-sight communications, Lockheed is studying the use of two earth-orbiting satellite tracking stations, 8000 miles apart. Not only would great accuracy be gained by the separation, but it would be further enhanced by the positioning of the stations above the earth's atmosphere, thus eliminating atmospheric distortion.

Examples of other research projects being pursued by Lockheed in the communications area include: Random multiplexing, satellite readout techniques, scatter communications, radar mapping, submarine tracking, modulation of optical energy, communications over multipath channels, and learning systems.

LOOK AT LOCKHEED... AS A CAREER Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile and the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for individual recognition.

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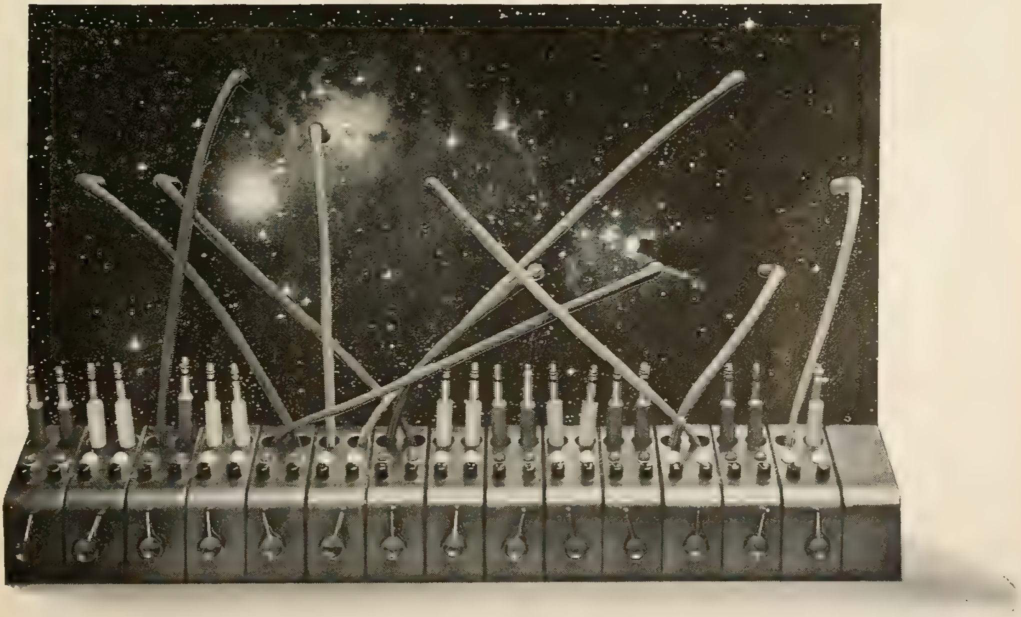
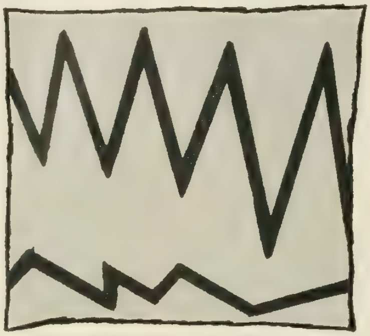
Where outstanding successes have created aerospace leadership



Which one is the shark?



Is it shark talk or salmon mutterings? Fish or sub? Friendly sub or marauder? Can you convert the sound to data? Store it? Recall it? Analyze it?

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Division of North American Aviation

MANNING THE FRONTIERS OF ELECTRONIC PROGRESS

Robert D. Einehart: Appointed component engineering manager in the engineering department of United Aircraft Corp.'s Norden Div., Norwalk, Conn. **Leo Botwin** appointed radar systems engineering manager and **Frank S. Preston** named advanced engineering manager.

William C. Dell: Appointed a senior marketing representative in Washington, D. C., for United Technology Corp.

Dr. B. Dwight Culver: Appointed manager of the Life Support Systems Div. of Aerojet-General's Azusa, Calif., plant.

Milford B. Moore: Appointed president and general manager of Technology Instrument Corp. of California, Newbury Park, Calif.

Dr. John E. Tessieri: Elected executive vice president of Texaco Experiment Inc., New York City.

Dr. Elliott L. Katz: Appointed division manager of the Fluid Physics Div. of Electro-Optical Systems, Inc., Pasadena, Calif. **Dr. John M. Teem** appointed technical director of the organization and **Dr. Henry Richter** named manager of the advanced systems development operation.

Don P. Herron: Named Washington, D.C., director of public relations for the Martin Co. **Jerome L. Herold** named director of materiel and procurement for the Space Systems Div. of the Martin Co. at Baltimore. **Dr. Frederick A. Muckler,** a senior staff scientist in the human factors department of the Martin Co.'s Electronic Systems and Products Div., appointed by NASA to its Research Advisory Committee on Control, Guidance and Navigation.

L. A. Dougall: Appointed assistant sales manager of Vap-Air Div. of the Vapor Corp., Fort Worth, Tex. **L. E. Haskett** appointed electrical engineer.

Wesley S. Melahn: Appointed a vice president of System Development Corp., Santa Monica, Calif.

John O'Leary: Named production superintendent for National Transistor, a subsidiary of International Telephone and Telegraph Corp., Lawrence, Mass.

P. R. Gilson: Appointed manager-research and advanced development at Packard Bell Computer Div. of Packard Bell Electronics, Los Angeles. **R. A. Bennett** named manager-product development and engineering; **D. L. Pickens,** manager-systems engineering; and **R. H. Gibbs,** manager-engineering administration and services.

Dr. Edward B. Carne: Named manager of Melpar, Inc.'s newly formed Intelligence Dept., Falls Church, Va. **William H. Fuhr** named manager of the Advanced Computer Laboratory.

Robert E. Wolin: Appointed general manager of the Industrial Div. of Cubic Corp., San Diego, Calif.

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MAY

Institute of Electrical and Electronics Engineers, Seventh National Conference on Product Engineering and Production, Continental Hotel, Cambridge, Mass., May 27-28.

JUNE

Third Annual Reliability Institute, University of Connecticut, Storrs, Conn., June 2-14.

SAMPE Symposium on Space Power Systems Materials, Bellevue-Stratford Hotel, Philadelphia, June 3-5.

COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland, June 3-11.

17th Annual Convention and Exhibition, Armed Forces Communications and Electronics Assn., Sheraton Park Hotel, Washington, D. C., June 4-6.

National Electronic Packaging and Production Conference, New York Coliseum, New York City, June 4-6.

Symposium on the Exploration of Mars, sponsored by the American Astronautical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections and NASA, Denver Hilton Hotel, June 6-7.

Reliability Training Conference, sponsored by American Society for Quality Control, The Bishop's Lodge, Santa Fe, N. M., June 10-14.

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Cooper's Contribution

IN RETROSPECT, the most dramatic moments of astronaut Gordon Cooper's 22-orbit *Mercury* flight were not the launch or the landing but the matter-of-fact technical conversation between Cooper and fellow astronaut John Glenn as the preparations were made for re-entry.

The calm exchange between the two test pilots had a dramatic impact that smashed home, even to many outside the industry, the truth that man indeed is in space to stay.

There is a corollary to man wanting to climb the mountain because it is there: the mountain will be climbed because it is there.

So it is with space. Space will be conquered by man because it is there. Gordon Cooper's flight was one of the early steps along that road and there will be no turning back.

Ironically enough, the national debate on whether the U.S. should spend $20 to $40 billion dollars on its lunar program was nearing its climax simultaneously with preparations for the Project *Mercury* flight.

Congressmen, after applauding Cooper's flight, will vote through a slightly reduced National Aeronautics and Space Administration budget with a clear conscience and little fear that the folks back home now will rise in anti-space wrath.

The timing was good. The *MA-9* flight will have its beneficial impact both on the debate and the budget.

But the irony lies in the fact that the national space program is a necessity which exists regardless of the success or failure of a single launch.

Cooper's success will make its acceptance easier for a time. But the nation must be prepared for that grim moment when a space test pilot is lost—prepared and ready to continue on its multibillion-dollar path to the stars. Test pilots have been lost before—and they will be again. But the first U.S. space pilot to be killed will go to his death before the horrified eyes of the world.

Do not underestimate the potential impact of that moment on the future of the space program. Disaster can have greater impact than success. It may seem an unpleasant subject in the light of Gordon Cooper's magnificent flight in *MA-9*, but NASA and the industry should give some thought now to preparing the nation and the world for that agonizing moment. Failure to do so can endanger the entire space program.

It becomes more evident with each shot that the Soviet and U.S. space competition is indeed replacing war as an indicator of national competence and prestige—at least for this period. It also put upon the two societies an economic pressure that is equivalent to war. It is not too soon to begin preparation of the nation for the necessary sacrifices—both in lives and in money—to achieve the necessary victory.

The world's headlines were dominated by the Cooper flight. National elections took second place to the American in space. Those who argue that the prestige of victory in the lunar race will be momentary could not be more wrong. Our image throughout the world will depend greatly on how well we do in the lunar competition.

The Cooper flight also demonstrated the psychological impact an orbital weapon might have upon the world, to say nothing of the precision demonstration which indicated the ease with which an object—a nuclear weapon, say—can be returned from space to a predetermined spot. No time must be wasted in developing the defenses to quickly seek and neutralize any such weapon.

We certainly do not see eye-to-eye with *LIFE* magazine on many issues, but we applaud the Luce publication for its May 17 editorial entitled "World Will Be Ruled from Skies Above." The editorial points up the threat of an orbital weapon and gives prominent display to Air Force Lt. Gen. James Ferguson's testimony that an orbital space vehicle could deliver a nuclear warhead twice as quickly as could an ICBM. To those who might counter that 15 minutes can't be that important, we might ask why so many millions were spent on the Ballistic Missile Early Warning System (BMEWS)?

IT IS REFRESHING to see national commentators of the stature of *LIFE*, Roscoe Drummond, the *Washington Post*, James Reston and others turning to discussion and, for the most part, support of the national space program. The debate is beneficial; it makes clearer to the public many of the reasons why the multibillion-dollar space program must be funded. Debates serve to clarify issues. We are still confident that the American people, once they understand the issues, make the right decisions.

For the same reason, we are pleased that President Kennedy and NASA Administrator James E. Webb are carrying the case for the space program strongly to the public in recent speeches.

Both Drummond and *LIFE* have done the industry a service by pointing out that the real question is not whether we should be in a race to the Moon but, rather, who will master the entire spectrum of space technology with all its unseen future benefits.

It is this which justifies the multibillion-dollar expenditures, not a race with the Soviets to the first lunar landing. It still is possible that we will lose that race—but we never will lose the technology developed en route to the Moon.

It is the technology of the future. As *LIFE* says, "Now the U.S. can be foremost in another and greater adventure—or abdicate its own national greatness by not doing enough." As Drummond says, "The overriding issue is not who is going to be first to the Moon but who is going to be foremost in mastery of the new element of outer space."

In this new competition between the Soviets and the U.S., Maj. Gordon Cooper has indeed accomplished what might be called a Coop d'espace. It will be long remembered.

William J. Coughlin

The one-piston, no-cylinder space engine that runs for a year on a pound of gas

This is the Republic pinch-pulse plasma engine. It is just 9 inches long and weighs 5 pounds.

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Complete with controls, fuel supply, test instruments and electrical power source, the engine system has been operated in an environmental test chamber simulating actual conditions of space. Control information is telemetered into the test chamber.

This pinch-pulse plasma engine was built by Republic under contract to the Office of Naval Research. It is the prototype of a family of engines for satellite propulsion, stabilization, attitude control and rendezvous-and-docking in orbit.

One day its descendants will drive ships out beyond orbit . . . deep into the black vacuum of space.

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missiles and rockets

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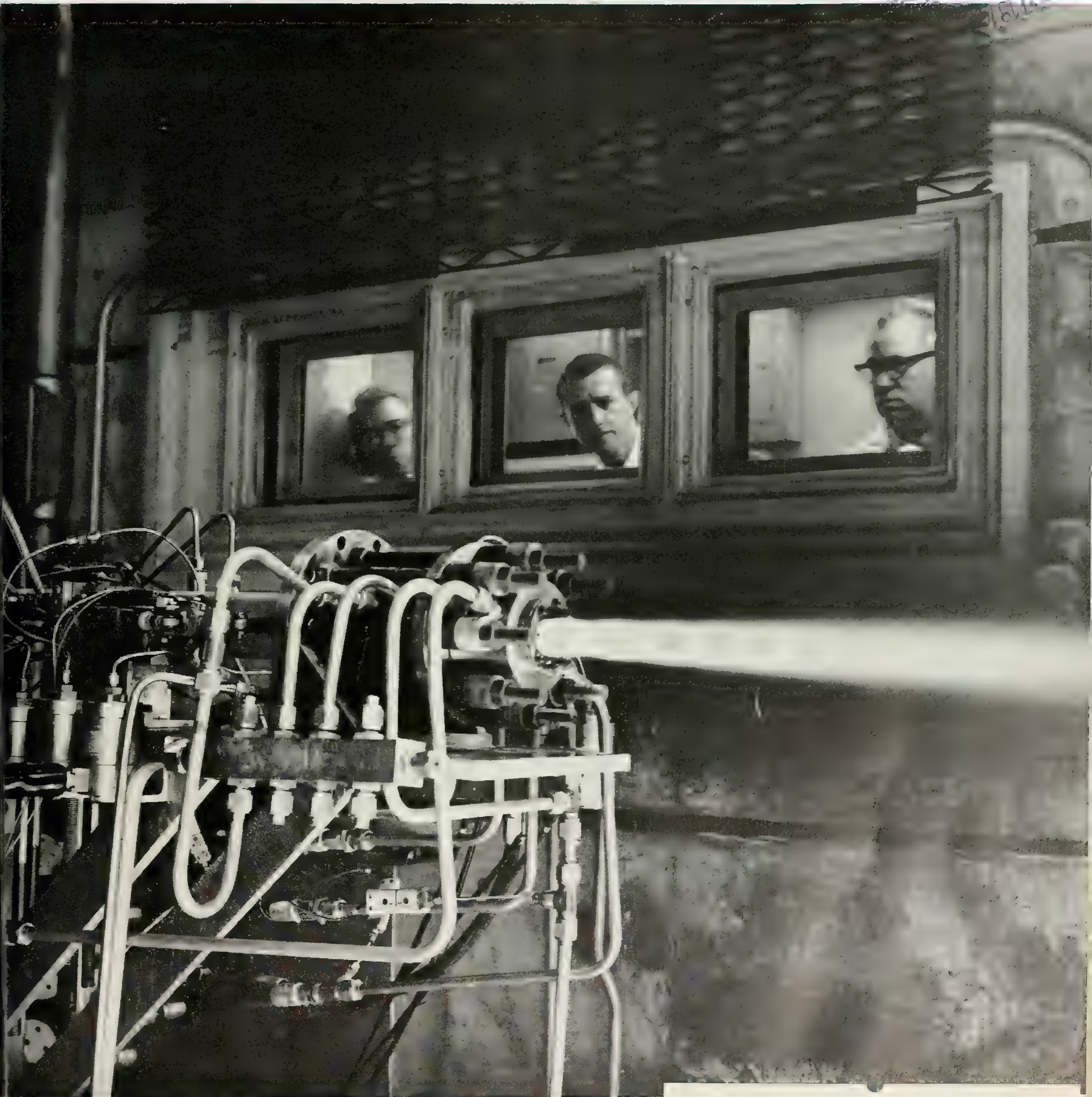
THE WEEKLY OF SPACE SYSTEMS ENGINEERING



Test-Firing STL's LEM Descent Engine Prototype

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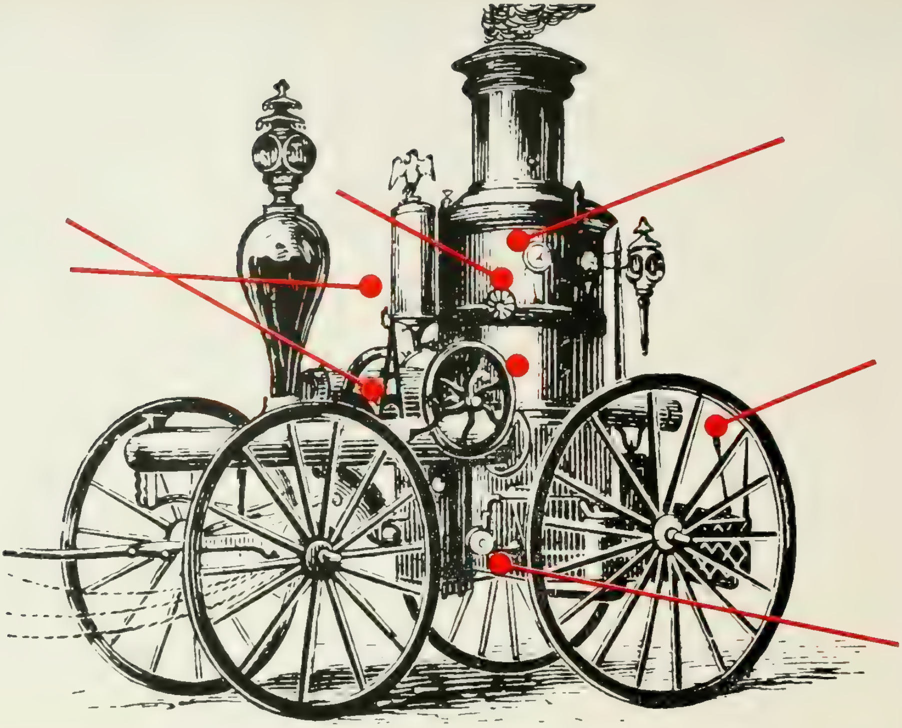

FORERUNNER OF REACTION CONTROLS?

Wondering what this ancient pumper has in common with reaction controls for aerospace applications? They're both based on the science of fluid dynamics . . . Vickers business for more than 40 years with emphasis on aerospace applications dating back to the early '40s.

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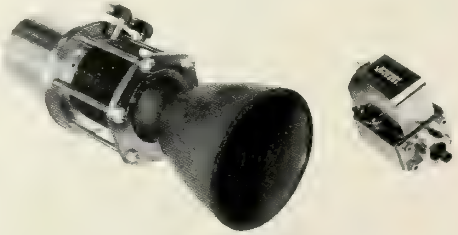

Vickers developments include a bipropellant 60-pound thrust rocket motor (left) and 1-pound thrust bipropellant motor (right). For more details about these and other recent aerospace developments write for Bulletin A-5283 "Harnessing Fluids for Airborne Uses" to: Vickers Incorporated Division, P.O. Box 302, Troy, Michigan.

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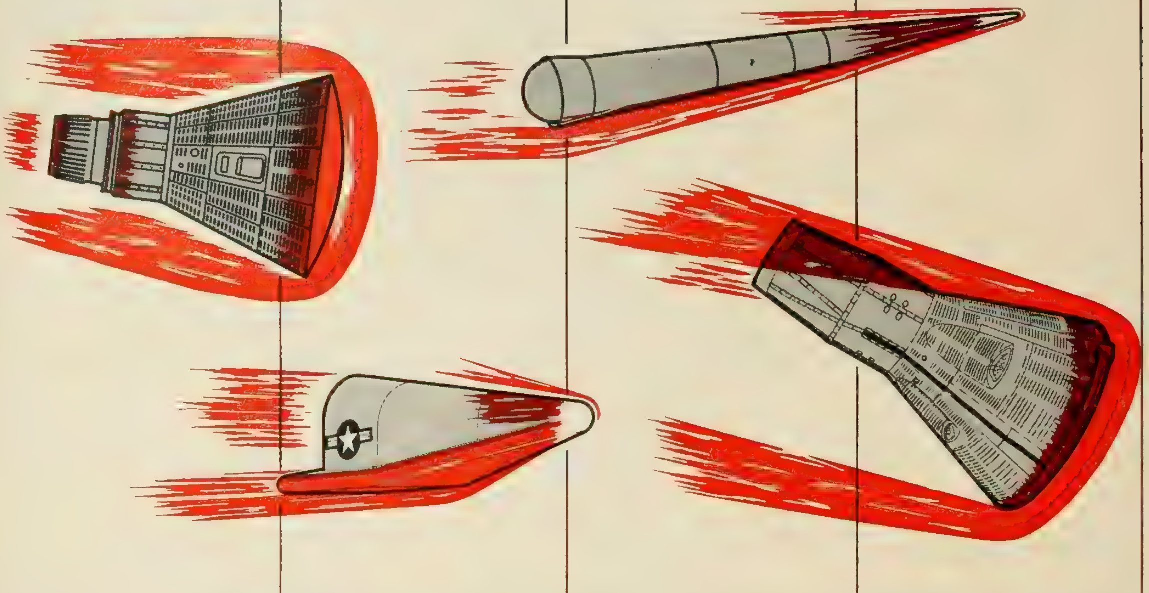
EARTH ORBITAL REENTRY

Four spacecraft programs, each engineered to explore diverse techniques for earth orbital reentry, are underway at McDonnell.



MERCURY

MERCURY, America's first manned orbital spacecraft, utilizes a non-maneuverable ballistic reentry. After retrorockets slow the spacecraft to bring it out of orbit, reaction jets position it for reentry. Mercury's ballistic shape maintains alignment with the drag vector as it follows a ballistic path through the atmosphere to drogue chute deployment at 21,000 feet. Final descent to an ocean landing is accomplished with a 63-foot ring-sail parachute.

ASSET

ASSET, an instrumented, unmanned, winged vehicle, will reach speeds of 13,000 miles per hour in sub-orbital flights at altitudes of over 40 miles. This space research program will provide for study of glide reentry technology, refractory materials fabrication experience, and accelerate the development of maneuverable reentry techniques. A parachute landing system enables recovery of vehicle and data package for post flight analysis of test data.

AEROBALLISTIC

AEROBALLISTIC is a word coined to describe the lifting body concepts proven by flights of McDonnell hypersonic missiles from Cape Canaveral in early 1959. The test flights demonstrated precise atmospheric control, the aerodynamic efficiency of an Aeroballistic vehicle and were the first breakthroughs in the design of maneuverable reentry spacecraft. Space missions utilizing an Aeroballistic type vehicle would terminate with a conventional runway landing.

GEMINI

GEMINI is a two-man orbital spacecraft for long duration and rendezvous missions. Upon reentry, the crew will position Gemini's off-set center of gravity with attitude control jets to re-orient the drag vector and create a lift component. This lift will enable the crew to maneuver Gemini to any point in a 28,000 square mile landing area. A paraglider will be deployed in later flights, enabling precise astronaut control of the glide to the landing field.

With MERCURY, ASSET, AEROBALLISTIC and GEMINI Spacecraft, McDonnell is perfecting reentry techniques, shapes, materials and manufacturing processes necessary for the achievement of U. S. leadership in space.

MCDONNELL

- *Mercury and Gemini are being designed and built by McDonnell for NASA under the technical direction of the Manned Spacecraft Center.*
- *Asset is being developed and built under the sponsorship of the Aeronautical Systems Division of the Air Force Systems Command.*
- *Aeroballistic vehicles were developed and tested under contract with the U.S.A.F. and development is continuing with company funding.*

TRADEMARK
FIRST FREE MAN IN SPACE

ST. LOUIS

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 22 June 3, 1963

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THE COVER

Space Technology Labs' 500-lb. throttleable engine in test bay. LEM descent engine prototype has been throttled in excess of 60:1, and design instantly dampens out induced combustion instability. STL has won a Grumman contract. See p. 24.

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44,800 copies this issue

Ability has no color, no creed, no nationality

Seen through the window of a huge protective "tent," a Surveyor Lunar Landing Vehicle undergoes checking.

What kind of mind does it take to conceive and build a Surveyor Lunar Landing Vehicle, a Falcon missile, a revolutionary 3-dimensional radar? It takes depth and breadth of technical competence. Highly developed imagination. Vision to perceive the usefulness of new ideas.

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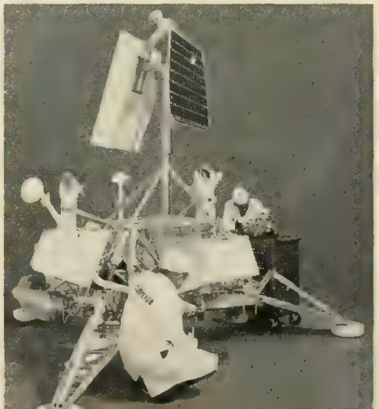

Before men can land on the moon, many questions must be answered about what they will encounter there. Specially-instrumented Hughes Surveyors will supply information on the trip to the moon and the conditions of "soft" landing on its surface.

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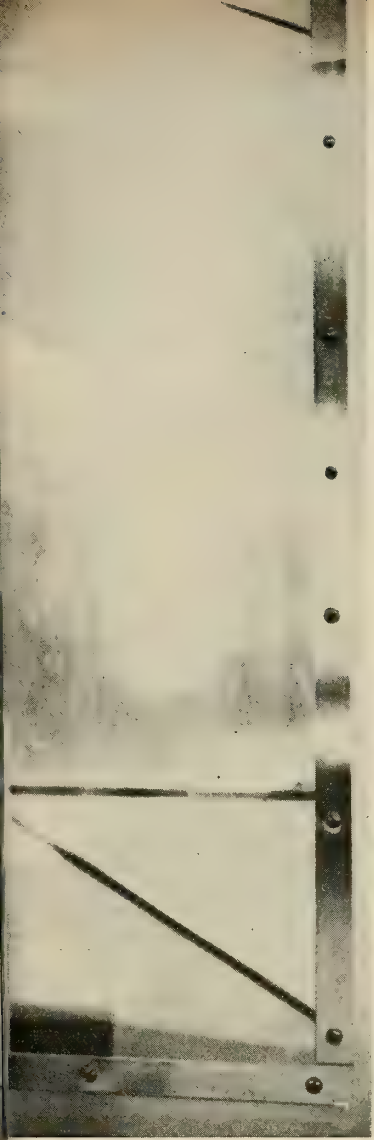

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letters

Military Needs

To the Editor:

I strongly concur with your recommendation in the editorial, "The Fallible Man," (M/R, April 29) that when we need a weapon, more than one alternative should be explored—at least through the demonstration phase.

I believe you do Mr. McNamara an injustice in implying that he wants to cancel all approaches to a military need except one. I see his actions more in the light of a struggle to deal with a large number of very expensive projects which might be judged to be technically questionable relative to the military needs of the country. His actions are needed in order to recover enough money from a constant budget so that we can have the quantities of the unglamourous equipment which may be necessary to maintain national prestige and flexibility under the assumption that a nuclear deterrent system will work.

Following your analogy, perhaps the actions we are seeing in the Department of Defense correspond to canceling the second and third approaches to the development of a Lincoln Continental in order to have funds for development of a Ford, Falcon *and* Edsel.

William B. McLean
Technical Director
U.S. Naval Ordnance Test Station
China Lake, Calif.

Further Re Alphabetese

To the Editor:

We have noted in M/R, April 22, a letter entitled "Guide to Alphabetese," written by Herr Reiner requesting information on abbreviations and acronyms used in the aerospace industry. We would like to draw to his attention a publication by the undersigned, *Missile and Space Projects Guide,* which lists nearly all projects, past and present, U.S. and foreign, proposed and initiated, by name, designation, and acronym, as well as numerous other abbreviations, including government agencies.

The *Missile and Space Projects Guide* was advertised in M/R, March 25 (p. 161), and is obtainable from Plenum Press, 227 West 17th Street, New York 11 N. Y.

Horace Jacobs, Ph.D
E. E. Whitney
Lockheed-California Co.
Burbank, Calif.

Dynatech Generators

To the Editor:

We certainly appreciate your mention of Dynatech Corporation's superconductive generator program in your May 6 issue (Technical Countdown, p. 21). We would like to point out, however, that an error was made in your generator description. Apparently, the results of our company-sponsored program were confused with the specifications of our new Air Force contract.

The ¼-½-kw supergenerator described in your article is the generator we built and tested during our own program. Our Air Force contract covers the design and supporting research for a 1000-kw supergenerator.

We would appreciate your bringing this to the attention of your readers.

W. W. Welsh, Jr.
Government Marketing Manager
Dynatech Corporation
Cambridge, Mass.

Causes for Concern

To the Editor:

I heartily concur with your March 18 editorial ("An Appeal to the President").

I also become a trifle upset when the Secretary of Defense talks about saving money and then NASA proceeds to start from scratch building their facility in Houston, which isn't close to either Canaveral or Vandenberg, or any other major aerospace facility.

The decision to scratch the *Dyna-Soar* project particularly concerns me. How in the world can we obtain information on reasonably controlled re-entries (other than the nylon let-down) if such a project isn't conducted?

Another aspect of NASA activities that gives cause for reflection is the de-emphasis on the military and the military aspect of space. Certainly it doesn't take any genius to figure that if we can drop a capsule out of orbit as accurately as was done with *Faith 7,* then there just might be a military application.

(Name Withheld)
San Francisco

Astrolog Reprints

Reprints of MISSILES AND ROCKETS' *latest Astrolog, the status report on missiles and space programs appearing in the May 6 issue, may be ordered from:*

Research Department
Missiles and Rockets
1001 Vermont Avenue, NW
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The reprint price is 35 cents per copy. Payment must accompany the order.

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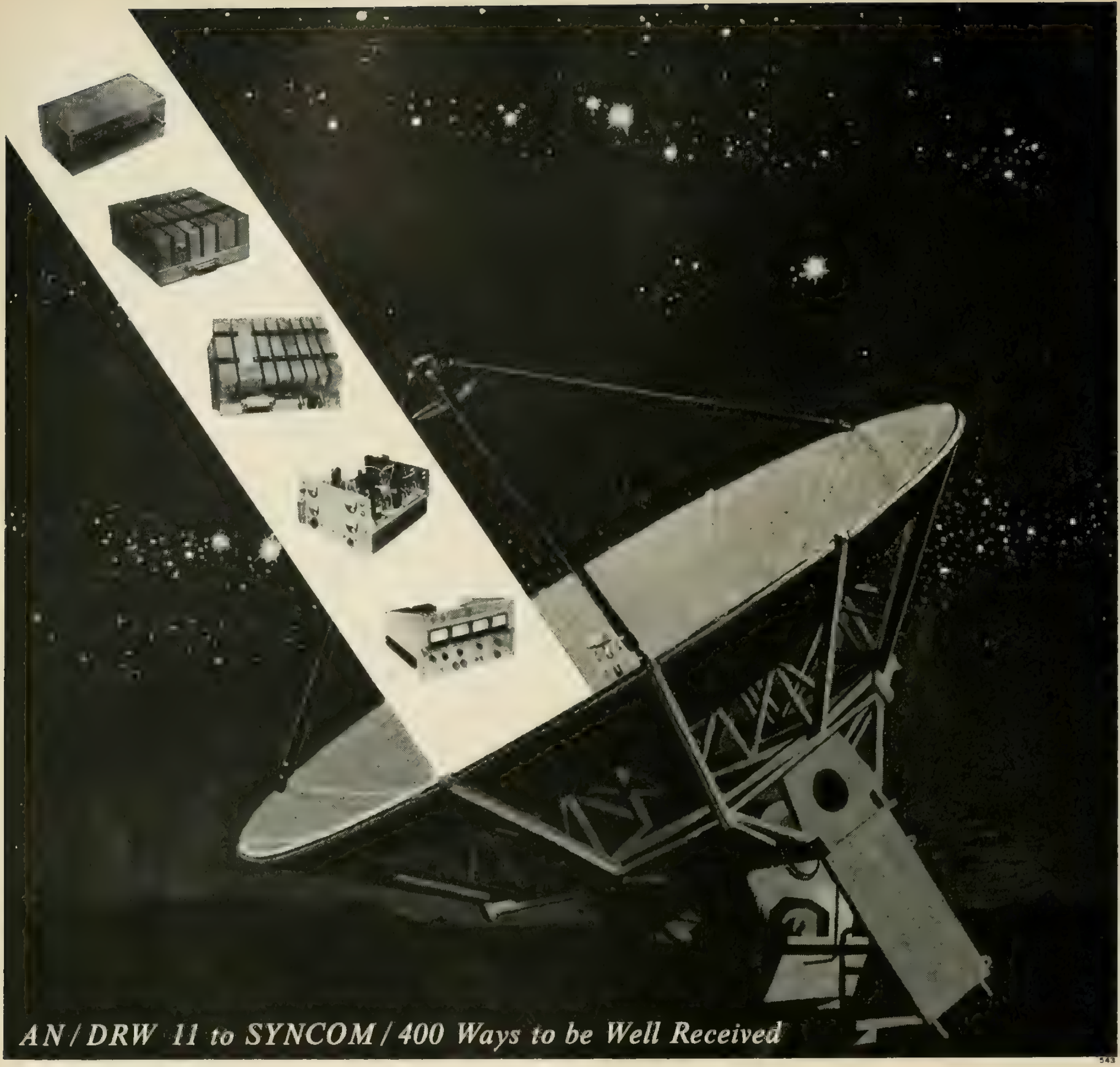

Since 1958, when it first built the AN/DRW 11 (a receiver whose primary function is to destroy malfunctioning missiles), STL has produced more than 400 space communications receivers of 14 different designs. The Able I receiver, the first phase-locked receiver ever to fly, was built by STL. So were the ground station parametric amplifiers that tracked Pioneer V 22 million miles into space. STL built the receiver now being used at Plermeur-Bodou, France, to track America's first communications satellites. The voice communications receiver for SYNCOM and the space command receiver for NASA's OGO are both STL products. Scientists and engineers interested in advancing the art of space communications will find Space Technology Laboratories an active place. STL builds spacecraft for NASA and Air Force-ARPA, and continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. To obtain additional information regarding positions at Southern California or Cape Canaveral, you may contact Dr. R. C. Potter, One Space Park, Dept. B-6, Redondo Beach, California, or P.O. Box 4277, Patrick AFB. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

NASA Studies Lunar Reconnaissance Module

NASA's Manned Spacecraft Center has asked for proposals by June 7 on a six-month study of a special Lunar Reconnaissance Module (LRM) for the *Apollo* program. As an alternative, the agency also is funding a study of reconnaissance probes to be launched to the lunar surface from an orbiting *Apollo* spacecraft. Behind the programs: concern over possible failure of *Ranger* and *Surveyor* to yield needed data on the lunar surface.

AF Plans GEM Launches for 1964

First launch of the *Guidance Evaluation Missile (GEM)* is set for 1964 under current Air Force planning. Interest in the program, which will test guidance systems in powered re-entry, is centered around the recovery package. Booster will be a combination of standard vehicles, with configuration varying with the mission. AF now is discussing proposals with contractors. Among vehicles under study: *Scout* and *Pershing*.

NASA Interested in RCA Biosatellite

NASA is showing interest in an RCA proposal for a non-recoverable biosatellite based on technology already developed in the *Sert*, *Relay* and *Tiros* programs. The 220-lb. satellite would be launched by a *Scout* booster. Program would test effects of zero-g on bean sprouts and algae, with TV cameras transmitting photos back to Earth.

Pentagon Readies Contractor Rating System

The Pentagon's new uniform system for rating contractors is ready for application. It will be put into use early in the next fiscal year. Interservice teams were assigned six months ago to develop the system, which will evaluate and record the performance of defense contractors.

Air Force To Acquire Own Gemini Capsules

A top Air Force spokesman says that service is considering acquisition of as many as six of its own *Gemini* capsules, modified to meet military requirements. Under present plans, according to research and development chief Lt. Gen. James Ferguson, AF will wait until several NASA *Gemini* firings provide further insight into the configuration needed before initiating procurement.

NASA Asks Bids on One-Man Lunar Booster

NASA's Manned Spacecraft Center has called for bids on study and preliminary design of a one-man propulsion device for use on the Moon or in free space. The agency says it wants a detailed theoretical analysis of the mechanics involved in transporting one person and a small number of instruments or tools in a zero-g or lunar surface environment. The concept must include capability to descend or ascend steep crater walls. RFP deadline: June 20.

Outlook Is Brighter for SAINT

Air Force has Dept. of Defense approval for an increase in funding of the *Satellite Interceptor* program whenever technical progress warrants. This is expected next fall. The program still is classed as "active" despite its reorientation by AF last year. Reason for the reorientation: too little knowledge at too great a cost.

Pentagon To Increase Contracting Tours

Longer tours of duty for officers concerned with weapons system acquisition—long regarded by industry as desirable—now are in the works. The new Dept. of Defense setup, to be applied to both officers and civilians, also recognizes the need for a separate management office "when conditions of advanced technology, military urgency, high cost or management complexity are present." Training and promotion policies also will be adjusted.

SAMOS Is Operational; MIDAS Is Not

Air Force now regards its *SAMOS* spy satellite program as operational. Meanwhile studies in the re-oriented *MIDAS* program indicate the concept of a satellite missile detection system "definitely in the realm of practicality." This means a step-up in *MIDAS* activity.

NASA Seeks Use for MA-10 Capsule

If no manned *MA-10* mission is approved, NASA will welcome suggestions on projects which might be programmed for the unused *Mercury* capsule and booster. Aside from this, the space agency's Office of Advanced Research and Technology already has asked companies and universities to submit concepts for experiments applicable to life support systems for men and equipment. To be flown on space laboratories and probes, some of these might conceivably wind up in the *MA-10* capsule. Deadline: July 15.

Pentagon Issues New Guide on PERT

Dept. of Defense is issuing a follow-up to its guide on PERT-cost. The new manual, sponsored jointly by DOD, NASA, AEC, FAA and the Budget Bureau, will prescribe standard practices for all phases of the PERT time and cost systems. The initial guide, issued last June, has sold 25,000 copies through the Government Printing Office.

INDUSTRY

Goodyear Cuts Subroc Motor Cost by 50%

Goodyear reports it has cut cost of the *Subroc* motor by over 50% without any sacrifice in the development schedule. Technique: use of PERT supplemented by manpower utilization standards.

ComSat Corp. Heads Visit Europe

The chairman and president of the Communications Satellite Corp., Leo D. Welch and Joseph V. Charyk, were in Europe last week on a trip which includes visits to Ottawa, London, Paris, Bonn and Rome. Purpose: exploratory talks with communications officials regarding an international ComSat system.

INTERNATIONAL

First German Satellite in Design Stage

Boelkow-Entwicklungen, Munich, now is designing a 3000-lb. satellite for use in communications, meteorology or geodetic projects. Backing from the West German government is expected. Plans call for launching, probably by a U.S. vehicle, into a near-polar orbit with a 400-km. apogee and 150-km. perigee.

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The Missile/Space Week

Air Force MODS Hopes Rise

Virtual confirmation came this week that the Air Force, rather than NASA, will run *MODS—the Manned Orbital Development Station* (M/R, May 27, p. 15).

Lt. Gen. James Ferguson, AF's deputy chief of staff for research and development, said the Air Force hoped to start developing "soon" a military orbital space station that could stay aloft indefinitely with men aboard.

The station was described as a key element of a future "military patrol" that would defend American interests in space.

Ferguson said that though the development effort may include NASA, the station could be used as an operational combat vehicle when its early space-lab mission ended.

Contracting System Scored

An industry spokesman and a representative of the Defense Dept. have underscored the need for a better system of awarding defense and space contracts.

Kenneth S. Kelleher, president and founder of Aero Geo Astro Corp., and Robert Tucker, DOD's assistant director of engineering, cited the need at a two-day NASA conference in Washington.

Kelleher called for a better system to evaluate bids. He said further that bid lists are a ridiculous size, and that too much detail of construction is required. He added: "I cannot yet understand why a low bid award is the safe course for the procurement officer, but we all know that it takes an unusual kind of courage to turn down such a bid."

Tucker said a survey of 12 defense projects in 10 years showed they cost 3.2 times as much as the original bids. He suggested a more detailed analysis of costs before awarding contracts.

Merritt Island RFP's Due

NASA will request proposals from industry shortly after July 1 for three major support service contracts at its Merritt Island Launch Area (MILA), Cape Canaveral.

The three contracts cover launch support, administration and management, and base services, according to an announcement by the Launch Operations Center at Cape Canaveral.

Procurement action has already

Apollo Abort/Pitch Motor Detailed

SOLID PITCH CONTROL motor for the Apollo launch escape system is automatically welded at Lockheed Propulsion Co. The PCM eliminates the need for a conventional steering device on the launch escape motor and is designed to kick the entire Apollo spacecraft into a correct flight trajectory for successful escape during a launch malfunction. The variable-impulse unit has a burning time of 0.5 sec., weighs less than 100 lbs.

been initiated for one other major award. Some 35 contractors attended a pre-proposal conference for the prime communications contract for the new launching area for the manned lunar landing program. Selection of the contractor is expected about July 15.

The four contracts will cover some 25 separate support functions. NASA said the action was taken "after extensive study concluded that such a system would assure the quality and timeliness of response required from service elements in support of the manned lunar landing programs."

It added that the four prime contractors will be required to subcontract a substantial part of their operations to small business firms which have demonstrated capability in the required specialized areas.

Release of the procurement plan ends a long dispute between NASA and the Air Force over the management of support services at the space agency's new launch area.

The Air Force, as host agency at the Atlantic Missile Range located at Cape Canaveral, wanted NASA to utilize the same industrial team that provides support services at Cape Canaveral. Currently, Pan American serves as the prime contractor for support and administration of AMR. It selects and directs all subcontractors under the overall supervision of the AF.

NASA officials, in reviewing the AF operations, decided that they would rather have several prime contractors in order to have more effective control over the total operation.

Shots of the Week

- A *Titan II* launched May 24 from Cape Canaveral scored a near bull's-eye on a 6,500-mile flight down the Atlantic Missile Range, dropping the nation's largest nose cone within a mile of its target. The flight marked the third time the 10-story high, Martin-built ICBM has carried the big payload over the same route, and was the ninth success in 15 flights.

Measurements taken during the flight revealed vibration was within acceptable limits for boosting a manned *Gemini* spacecraft.

- Tass, the official Soviet news agency, reports Russia made a series of 7,500-mile shots (total number not disclosed) into target areas in the central Pacific May 18 and 25 in support of its manned space program.

The firings are said to have had a "high degree of accuracy." The rockets were identified merely as "perfected variants of carrier rockets for outer space objectives."

- Latter Soviet shots followed a May 24 firing of a rocket bearing *Cosmos 18*, the latest of five unmanned, instrumented satellites launched by the Soviets in the last six weeks.

MTO Gets Labor Peace Pact

Labor peace at NASA's Mississippi Test Operations facility has practically been assured through a tentative agreement reached May 21 in New Orleans between construction contractors and union representatives.

The agreement between the Gulf Coast Contractors' Assn. and the Building Trades Department, AFL-CIO, must be ratified by the local unions involved before it becomes binding.

Negotiations already are under way to determine the wage scales covering approximately 3,000 workmen during the three-year period.

The pact is the result of the first such "preventive" labor relations conference sponsored by the federal

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

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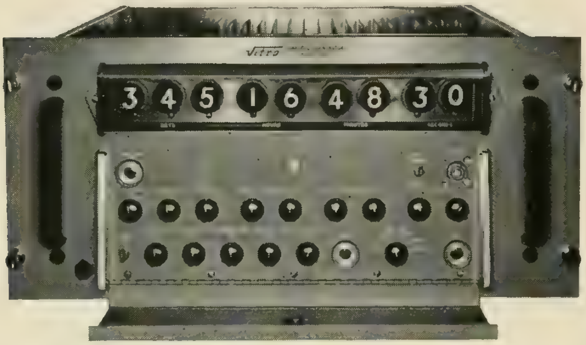

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government in advance of construction contracts awards.

The test site, located in Hancock County, Miss., will be used in ground testing engines and stages for *Saturn-Apollo* launch vehicles used in the nation's manned lunar landing program.

Pan Am Wins NRDS Award

Pan American World Airways has been selected by the AEC-NASA Space Nuclear Propulsion Office to enter into negotiations to provide support services at the Nuclear Rocket Development Station in Nevada. Twenty-eight firms submitted bids.

The contract, which will be in the range of $5 to 7 million annually, will call for plant engineering and housekeeping, temporary storage of radioactive wastes, computer operations and operation of shops and special vehicles.

The contract also will provide for limited support by Pan Am to Westinghouse Electric, Aerojet-General, Lockheed Missiles & Space Co., and other contractors in the nuclear rocket R&D program in Nevada.

Martian Atmosphere Analyzed

The Martian atmosphere contains almost no water vapor, and the famous "polar ice caps" probably are composed of thin layers of hoar frost less than a hundreth of an inch thick.

This is the report of astronomers who analyzed the infrared observations of the *Stratoscope II* balloon-borne instruments flown last March from the National Balloon Launch Center at Palestine, Tex.

"We detected no water with certainty, and we therefore conclude that the amount of water vapor in the Martian atmosphere is certainly less than 0.004 and probably less than 0.001 of that in the Earth's atmosphere," the Princeton and University of California scientists reported. Results were obtained by a bolometer flown at 78,000 ft.

Another *Stratoscope II* flight to measure infrared radiation is scheduled for October from the Texas launch center.

Five scans of Mars by the bolometer confirmed a high concentration of carbon dioxide. Carbon dioxide may constitute more than 2% of the Martian atmosphere; Earth contains about 0.02% of carbon dioxide and 0.1% water vapor.

Authors of the report were Dr. R. E. Danielson, J. E. Gaustad, Martin Schwarzschild and Neville J. Woolf of Princeton and Dr. Harold Weaver of the University of California at Berkeley.

Cape Rail Track Bids To Open

Bids will be opened June 20 in the Jacksonville, Fla., office of the Army Corps of Engineers for construction of a $2.5-million railroad track system to serve NASA's Merritt Island Launch Area (MILA). More than 18 miles of track will be laid to bring rail service to the MILA industrial area and to the multiple launch pads of the *Saturn V* Complex 39 on the ocean front.

The NASA rail lines will extend from a marshalling yard on North Merritt Island, where loaded freight cars will be delivered by the Florida East Coast Railroad Co. Extension of the FEC lines to Merritt Island marks the first time direct rail service has been available to the Cape Canaveral complex since missile and space activities started nearly 13 years ago. Previously, all material was trucked from the mainland to the Cape.

The Engineers' contract will call for completion of the work within 180 days to permit direct rail delivery of large quantities of structural steel needed to build the 524-ft.-tall *Saturn V* vertical assembly building. Delivery date for the steel is set for February.

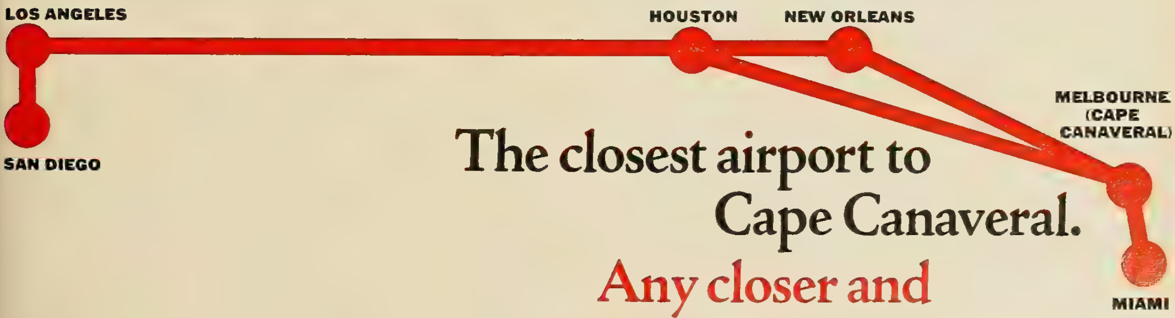
Manned Mars Trip Proposed

A manned expedition to Mars, using one of its moons as a staging area, has been proposed in a study conducted at NASA's Jet Propulsion Laboratory.

Eugene F. Lally, senior research engineer, told NASA's seminar on Manned Planetary Mission Technology at Lewis Research Center, Cleveland, that use of a Martian moon would allow careful advance calculations of Martian entry trajectories, landing site selections and return trajectories.

Use of a spacecraft in orbit about Mars could be a more complex mission, he said.

Here's National Airlines' new thru-jet "Rocket-Run"



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No Apollo Slow-Down: Webb

In exclusive interview with M/R editors, NASA chief also opposes MA-10 flight, doubts MOSS will get funds in '65

NASA ADMINISTRATOR James E. Webb declares that there will be no slow-down in Project *Apollo* even if Russia drops out of the race to the Moon.

Webb, in an exclusive interview with MISSILES AND ROCKETS, also said that it may be optimistic to expect hardware development funding of a *Manned Orbiting Space Station* program in the Fiscal 1965 budget and placed himself in direct opposition to an *MA-10 Mercury* flight.

As far as the speed of *Apollo* is concerned, he said, "the work is going forward. Large amounts of investments have been made. We are in the middle phase of a program to capitalize on all these investments. My own view is that we would not want to slow up any of these things, no matter what the Russians do, because they give us a basic onward driving capacity in space and there are greater benefits to be achieved in this program than just competition with the Russians."

Webb said the talents of the *Mercury* team are needed now to solve many of the problems cropping up in the *Gemini* program and that this would be more valuable to the space program than an additional flight in the *Mercury* program. He said, however, that a meeting will be held with officials of the Manned Spacecraft Center to discuss the results of the *MA-9* flight. Another flight will be made, he added, only if there is an unexpected gap in manned space flight information.

In other important observations, Webb said:

- NASA is convinced of the need to continue the DOD *X-20 Dyna-Soar* program. It is unlikely that there will be joint funding of the program, but NASA would be happy to play a collateral role with the AF in a *Dyna-Soar* research project.
- NASA's Fiscal '65 budget may be slightly below the $5.7-billion Fiscal '64 request, if no new programs are authorized.

Highlights of the Webb interview are presented below. The questioners are M/R Editor William J. Coughlin and Associate Editor Hal Taylor.

'Flight Envelope' of Mercury Program Is Now Completed

Q. *There seem to be a lot of people in the space agency who feel an MA-10 flight should be made. They say that it could replace two Gemini flights of short duration—or in any case permit the Mercury flight-control team to get more experience.*

A. We can speculate what people think and what the inner feelings are, but I think the facts would be as follows: We have, we think, learned from *MA-9* enough information to complete what we call the flight envelope. As to whether or not you would make another flight, the policy of the agency has never been to make these flights just to make flights. There has to be a reason. We never make an *X-15* flight just to make a flight. We make it because there is a gap in the knowledge—something that can be usefully learned from the flight. . . . Bear in mind that we will fly before the end of this year, or certainly next year, the first *Titan* with an aerodynamic model of the *Gemini* capsule. This is not very far away. Bear in mind that following that, within the period of about 3 or 4 months, we will be flying *Gemini* with most of its systems in it, and that we will sometime in the latter part of the summer or early next fall be flying a manned flight with the *Gemini*. Now, the same men who have done so much to develop the *Mercury* need to apply their skill and experience to the *Gemini* system. Let me tell you what I mean by that. First of all the *Gemini* flights will be much longer than the *Mercury* flights. A whole technique of managing long-duration flights must be worked out. A whole system of complete analysis of trouble if it occurs in the air must be worked out. And a much more complex method of analysis must be worked out. The whole guidance systems on the *Titan* must be most carefully examined and the whole set of procedures worked out in a manner that worked on the *Atlas*. I would say categorically that I would not be willing to fly an *MA-10* with the second team. That means our first team must be available until such time as the *MA-10* mission has been completed. If that is true, and if the first aerodynamic flight of the *Gemini* and the checkout of the *Titan* guidance systems to put things into orbit comes as early as next December or January, there is a tremendous amount of work to be done on the *Gemini* which offers far greater promise for progress in the U.S. space program than any expansion of *Mercury* could possibly offer. Indeed, many of the lessons we learned in *Mercury* which we thought would have direct application to the *Gemini* program have not worked out that way. The *Gemini* program has turned out to be a much more complex and difficult undertaking than even the experts thought when it was started—or even three months ago. So, as a matter of policy, unless there is additional information to be learned from *MA-10* we want to take the first team and put them to work solving these problems of *Gemini* and speed up that program as much as possible. And I don't think that anyone could say that the time of men like Walt Williams or the astronauts if applied carefully over the months ahead of us wouldn't have powerful effect on making certain that our systems for flying the *Gemini* gives the best that can be had out of it.

Q. *Has the decision been made?*

A. No, it has not been made. We have stated as a matter of policy that unless there are gaps in the information from *MA-9* or there is additional important information which we can get from *MA-10* we will not proceed with *MA-10*. But we are going to ask Walt Williams and Gilruth and others concerned to come up here for some discussions after they have had a chance to analyze the data from *MA-9*.

Q. *When do you expect to hold those meetings?*

A. They may come as early as this week . . .

"More Than Just Competition With Russia"

Q. *If Russia indicates it is not racing us to the Moon, will Project Apollo be slowed down?*

A. We have a program designed to serve the interest of the country. One of the factors determining the rate of this program is the necessity of catching Russia. They flew almost two years before Cooper's flight a flight of 17½ orbits. They are almost two years ahead. The policy of this agency is to be flexible enough so that we can speed up or slow down. This program is not a crash program. I think that the heavy investment in ground facilities makes it very unique, and these facilities are planned to serve the needs of the nation over a long period of time—10, 15, 25, 50 years. This gives us the space power, or at least gives us the capability of mobilizing space power in orbit. We could speed up the program considerably if it is necessary to do it. On the other hand, if the Russians should clearly indicate they have no intention of exploration of the Moon, would we slow up the *Saturn V?* Would we slow up the *Apollo?* The *Apollo* gives us the ability to orbit the Earth for two months, and the *Saturn V* gives us a tremendous capacity. The work is going forward. Large amounts of investments have been made. We are in the middle phase of a program to capitalize on all of these investments. My own view is that we would not want to slow up any of these things, no matter what the Russians do, because they give us a basic onward-driving capacity in space and there are far greater benefits to be achieved than just competition with the Russians.

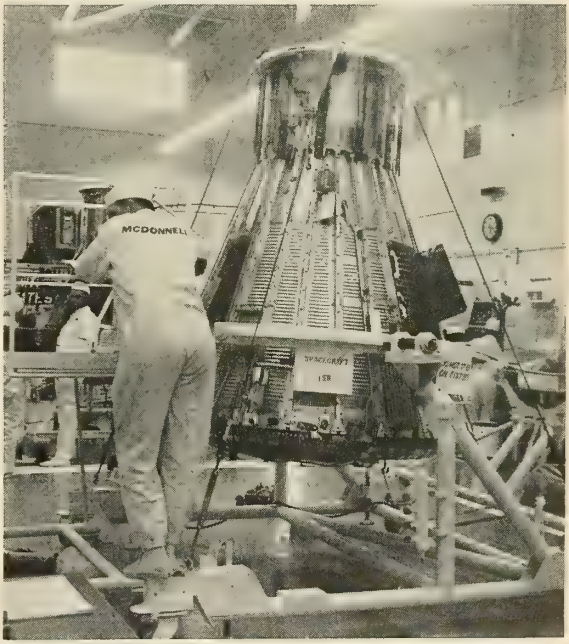
Q. *You have no indication, then, that the Russians are using a larger booster than the one used for the Cosmos series?*

A. None that you would call authoritative, or on which sound policy decisions could be made. There is always evidence of one kind or another on different matters of this kind, but nothing you would call authoritative or hard evidence.

MOSS Management "Secondary Question"

Q. *Dr. Lawrence L. Kavanau, special assistant for space to the Director of Defense Research and Engineering, said in Dallas that it might be a good idea to let the Air Force run the Manned Orbiting Space Station program. Do you agree with him?*

A. When you say it might be a good idea, I do agree with him. The thing that has happened in the space program is that while we have been developing a family of launch vehicles, a family of unmanned scientific satellites, a family of deep space probes and a family of manned spacecraft, we have also been developing organizations of men with competence to help make the future decisions. Now, the importance of the *Gemini* agreement has generally been overlooked. The importance is that the most capable technical people in the government are forming working relationships in the area of manned space flight, so that this very question that Dr. Kavanau has mentioned is going to be examined with greatest care. When you use the phrase "might be better run by the Air Force," the first thing you ask yourself is what is the station going to do? What is its purpose? Does the technology make it possible? If not, what areas of technology need to be developed in order to make it possible? Third, what does it cost? So I think you will see Dr. Kavanau's question becomes secondary for a while. The first thing will not be the question of who might do it best. The first question will be the three necessary analyses.



AWAITING FINAL DECISION—Mercury-Atlas capsule that could be used for MA-10 flight sits at Cape.

Q. *How soon do you expect to make a decision? Or has the decision been made in this area?*

A. I don't think anyone can answer this question at this time. We are embarking here on a number of studies with the Defense Department to see that the studies they make and the studies we make fit together as a pattern to give us a basis of judgment. . . .

Q. *Would this indicate there are some study contracts coming along shortly?*

A. Well, we have already let one or two from NASA, I think the Defense Department will very likely let some studies and I think it is entirely possible that we may join in some studies. . . .

Q. *There have been reports that this might be done in connection with the Fiscal '65 budget—that money would be included for development of a Manned Orbiting Space Station in the Fiscal '65 budget. Do you think that is too optimistic?*

A. I think that is on the optimistic side, myself. But, again I do not have enough information at this time to have a firm opinion. I think that the process right now, in this first half of 1963, is one of working together between the Defense Department and NASA and *Gemini* and making studies that will permit the next range of decisions. Bear in mind, there is a serious range of decisions involving other than the manned space flights. We have the communications satellite problem, both military and civilian to consider, we have the question of weather systems to consider. . . . I think the process of developing the cooperative working relationships is what is going on now. I think once they get more fully developed than they are at the present time you will see the benefits from our present system coming into being. . . . I think it is a little early to say that you will do this in 1965. I think the process through which the ultimate decision will be made is developing quite rapidly.

AF May Help Fund Gemini in FY '65

Q. *General Ferguson told the Aviation/Space Writers meeting in Dallas that the Air Force will probably wait for several NASA Gemini launches before deciding on the configuration for any Air Force-purchased capsules. Would you comment on that?*

A. I think this may be true. You see, we have an active, going program and have purchased 12 *Gemini* capsules. Now, there are clearly a number of developments in connection with the rendezvous technique, with precise launch times, with the experimentation as to how to change the orbit of the satellite, and many things at this time that can be conducted within our program. Many additional things could be done if we add one, two, three or four flights to our program and operate this in such a way as to give the maximum advantage to both the Air Force and NASA. . . . But I think it is too early to tell how the nation can get the best utilization from the *Gemini*. It is perfectly clear we are going to have a very good space vehicle that can stay in orbit for long periods of time, that has some propulsion capability that can change its orbit. Now, these are tremendously interesting areas of experimentation. But most people don't realize the limitation. To change the orbit of a spacecraft traveling 17,500 to 18,000 miles an hour takes a tremendous amount of energy. You don't do very much changing of orbits even with something like the *Gemini*. When you get on to the *Apollo* there will be a good deal of ability to change orbits. But the amount of power to change the orbits is tremendous. And this limits the utilization of *Gemini* for more than a certain range of experiments. . . .

Q. *Would you expect AF funding for Gemini in the '65 budget?*

A. My own guess is that there will be some funding for *Gemini* experiments for the Air Force in the '65 budget. But I don't think that anybody knows that. That is just a prediction of what study groups will find, and these study groups still have not had any chance to do their work.

"Gemini Could Be a Space Age DC-3"

Q. *There has been some talk that, because in 1965 Gemini and Apollo will come together, and you may have flights in both programs, that NASA may lose interest in Gemini and perhaps even turn it over to the Air Force.*

A. No, this is just a complete misconception of the vehicle. . . . The thought that we may lose interest in *Gemini* is like saying the Douglas company would have lost interest in the DC-3 as soon as World War II was over. I think the *Gemini* could well be a DC-3-type instrument for space use for a long period to come. I think it may well be used not only by the military and NASA, it might well be used by other agencies of government.

Q. *Do you feel then that the Mercury may not be a DC-3?*

A. I will be able to state categorically that it will not be a DC-3. Mainly because of the limited capability of the *Atlas* booster.

Q. *There has been some talk about NASA building a Lunar Logistics System, and officials of the Office of Manned Space Flight say there will be a decision by mid-1963. Do you expect a decision that soon?*

A. I don't think you will have a final decision that soon. The questions of what operations ought to be conducted around the Moon and the surface of the Moon, following the first landing, are going to be considered over a longer period of time than that. . . .

Q. *There has been some discussion about the review of the Dyna-Soar X-20 program now under way. I wonder if you care to comment on NASA's interest in the X-20?*

A. I'll be glad to do that. Again, as in all these programs, we have had very careful and thoughtful consideration of it at the highest level. As you know, Secretary McNamara and I have discussed this subject quite a number of times, and he has very kindly asked us to submit our views. We have expressed to him and I will, I am sure, in the further discussions, point out to him that a maneuverable manned hypersonic re-entry vehicle is quite important for the total range of the space technology which this nation needs. Just as the development of *X-15* filled an important area of information needed, so does the *Dyna-Soar* have the important function of giving us knowledge beyond the recovery techniques we use in *Mercury*, *Gemini* and *Apollo*. We think, here in NASA, the U.S. should not leave this gap in its information about operating in space. We also believe that the *X-15* and *Mercury* projects show the value of having a manned vehicle for this kind of research.

Q. *If Secretary McNamara requested it, would you offer to help fund the program?*

A. I don't think this would be decided by one administrator like myself. I would say that is a decision of the President and the Director of the Budget. . . . Now, there are cases where joint funding and joint management is good, because it requires both parties to participate actively and vigorously and assume their part of responsibility. Generally speaking though, I favor, and I believe Secretary McNamara favors, direct responsibility for both funding and program direction on the behalf of one agency, with a collateral role for another.

NASA will be very happy to play that collateral role for *Dyna-Soar* as a research project.

Q. *As long as we are on the subject of money . . . as regards the Fiscal '65 budget, can you say whether it will continue at about the same level as the '64 budget?*

A. If no new projects are added other than those for which funds were requested in 1964, the '64 and '65 budgets will be the top, and you will begin to get a decline in the request for appropriations.

Q. *If you don't undertake any new projects will the Fiscal '65 budget be about the same as the '64?*

A. Perhaps a little over . . . ■

By RCA-Princeton . . .

New Tiros 'Wheel' Design Studied

Modification may answer frequency, time questions; has IR limitations; interagency agreement reported

by Michael Getler

A NEW "WHEEL" configuration now being studied for *Tiros* by engineers at Radio Corporation of America may make a significant contribution to development of new meteorological satellite observation techniques. But infrared payload limitations probably will restrict its use.

The $100,000, four-month study, funded by NASA last week and now under way at RCA's Astro-Electronics Div., Princeton, N.J., will explore the feasibility of rotating the "hat-box"-shaped satellite in orbit so that its spin axis is maintained perpendicular to the orbital plane, giving the vehicle the appearance of a wheel riding on an orbital track around the Earth.

By repositioning the two on-board TV cameras so that they point in opposite directions through the rim of the vehicle, extensive daytime cloud photo coverage can be provided.

With the satellite rotating at 12 rpm, the two cameras can be sequenced to provide a cloud-cover photo every 30 seconds minimum, with selective variation capability, the intervals being spaced to avoid excessive overlaps of the photographs.

In a 400-mi. polar orbit, complete Earth coverage could be obtained every three days, NASA reports. Rectification problems also are eased with the cameras in this position.

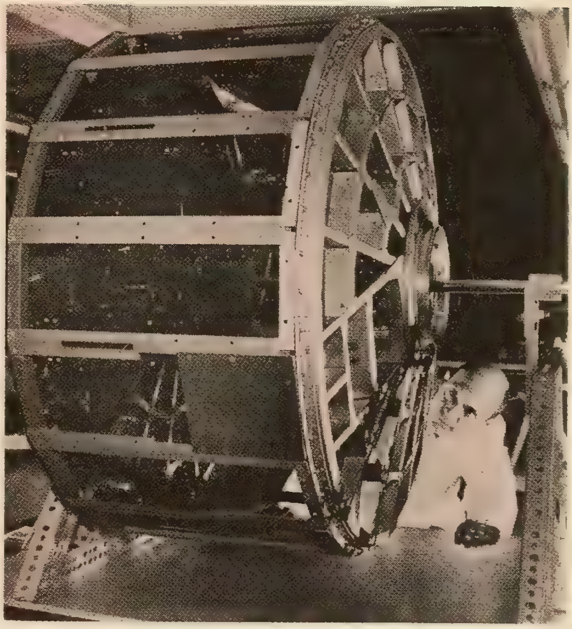
In the current *Tiros* design with the spin axis maintained in the orbital plane, the cameras look down through the satellite base-plate parallel to the spin axis. In this orbital attitude, the time the Earth is in the optical field of view under proper illumination conditions is limited to about 25%.

The RCA evaluation is said to be tied in with other space agency studies now investigating the feasibility of putting future experimental *Tiroses* into polar orbit to further optimize viewing. The inclined orbital paths used for *Tiros* thus far substantially limit coverage.

- **Contract optimism**—Present RCA funding extends only through a "paper analysis." No hardware will be built until the approach is approved.

Essentially, very little new hardware would be involved.

The wheel design will allow NASA to make detailed studies of both the optimum frequency of observation and the time at which the observations are made. NASA describes its second-generation *Nimbus* satellite as being "set up on a high-noon orbit." There is a question one top official reports, as to "whether it is better to take pictures at a different time. We can make these tests much more economically with *Tiros*."



RCA ENGINEER checks structural tolerances on Tiros frame. Satellite would be oriented in this position

NASA says the major drawback to growth of the "wheel" concept for *Tiros* beyond the observation experiment stage is that "it is useless for all IR scanning and measurement of Earth's albedo, thermal radiation, and distribution of nighttime cloud cover." In the traditional *Tiros* design, the spin-stabilization generates the IR scan line and the orbital motion acts as the advance along the line.

Though earlier *Tiroses* have provided valuable IR data, NASA does not expect to get good night IR cloud-cover data until it moves into the *Nimbus* program. This type of data, combined with the "infinitely better" resolution expected from all *Nimbus* viewing systems, will move scientists much closer to what the space agency considers the most significant meteorological parameters—wind and pressure fields.

- **Interagency accord**—Commenting on the reported "disagreement" between NASA and the U.S. Weather Bureau (M/R, May 27, p. 9) concerning configuration of a number of operational versions of *Tiros*, both government and industry sources report that there is now essentially an agreement between the two agencies concerning both R&D and so-called "standard operational" types.

Some delay in the program was reported to have caused contractors to "sit tight on areas that might be subject to change." But one project officer reports that "we expect a clear-cut configuration release on both groups of satellites within the next few weeks."

Though a go-ahead may be given to an operational "C" version of *Tiros*, NASA reports it may proceed more as an accumulation of hardware—and it's possible that such satellites may never be launched. NASA officials say it is "very unlikely that they will be launched before the first experimental *Nimbus* slated for late this year." If *Nimbus* is successful, NASA says, "we may never need them." ■

Effective July 1 . . .

DOD Plans More Equitable Contracting

Congress told use of incentives to increase; weighted guidelines to be applied to profits

by Frank G. McGuire

A NEW Defense Department policy aimed at reshaping the contracting situation into a more equitable, consistent pattern has been described to Congress.

Use of a weighted guideline system for determining contractor profits will go into effect July 1, on a permissive basis, for six to nine months. After that, it will be mandatory that all contracts on which cost analysis is performed be prepared under the weighted guideline system. The new approach will not apply to certain kinds of contracts, including those in which costs are not analyzed and those signed with non-profit institutions.

Thomas D. Morris, Assistant Secretary of Defense for Installations and Logistics, told the House Subcommittee on Government Operations that cost-plus-fixed-fee (CPFF) contracts, which reached a peak of 38% of all DOD contracts in the first nine months of Fiscal Year 1961, now have been cut to 22.7%.

The ultimate DOD goal for CPFF contracts, to be limited mostly to basic research awards, is 12.3% by FY '65.

In dollar figures, these statistics amount to a $3.2-billion reduction in CPFF for all of FY '63, with a savings estimated by Pentagon management at about 10% of what would otherwise have been spent, or $320 million.

"We had found that the CPFF contract was conducive to cost overruns and slipped schedules because it failed to require the government and the contractor to think through precisely the objectives being sought in respect to performance, delivery and cost," Morris told the subcommittee.

Hand-in-hand with the reduction of CPFF contracts has come an increase in both firm-fixed-price and incentive contracts. These increased from 30.4% in the first nine months of FY '61 to 41.3% in the first nine months of FY '63 for firm-fixed-price contracts. Similarly, cost-plus-incentive-fee contracts increased for over the same nine-month periods from 2.7% to 10.7%. Fixed-price incentive contracts increased from 9.7% to 14.8% in the same time periods. Other types of contracts dropped from 19.2% to 10.5% as a result of the trend.

- **Profit determination**—Morris also described the new approach to calculating the contractor's profits on defense work, an approach put forward some months ago by Logistics Management Institute (M/R, Feb. 25, p. 15) which would use a system of weighted guidelines to determine proper profits.

"We have re-examined our profit policies," Morris said, "and target profits and fees now tend to cluster around a given percentage rate, depending on the type of contract and the industry, and this rate is perpetuated year after year. Field interviews with 100 of our contracting officers reveal that failure to discriminate more sharply in the level of profit or fee negotiated from contract to contract is due largely to the fact that the guidance now contained in Armed Services Procurement Regulations is too general, and that Departmental practices have tended to emphasize profit reduction rather than development of sound profit objectives based on the factors present in each situation."

He laid out DOD plans for overcoming these tendencies, including a requirement of contracting officers that they show exactly how the target objective or fee was arrived at, and what factors were taken into consideration; the issuance of factors that must be taken into account by contracting officers; and development of a weighted guideline system of assigning values to each of the factors involved.

"The purpose of the weighted guidelines," Morris explained, "is to clearly discriminate between low-risk situations—where the profit should be substantially below present norms—and high-risk situations where the target profit might reach the maximum allowed by law or sound business practices."

Included in the factors to be considered are:

- Contractor's Input to Total Performance as Measured by Costs:

1) Direct material 2) Purchased parts 3) Subcontracted items;

1) Engineering labor 2) Engineering overhead;

1) Manufacturing labor; 2) Manufacturing overhead;

1) General and administrative expenses.

- Contractor's Assumption of Contract Cost Risk:

1) Type, obligations, pricing provisions of contract.

- Record of Contractor's Performance:

1) Management;
2) Cost efficiency;
3) Reliability on cost estimates;
4) Timely deliveries;
5) Quality of product;
6) Research.

- Selected Factors:

1) Source of resources (Government or Contractor-owned);

2) Special achievement, if any, required by contract;

3) Other.

- **Review staff formed**—Within his office and under each of the Materiel Secretaries, Morris has formed a Procurement Management Review Staff to conduct continuing reviews of DOD's procurement operations. He said a review conducted by the I&L office in March showed that, in the case of large, high-dollar awards, incentive contracts are being made in a competent and businesslike manner and that realistic cost targets are being established.

"On the other hand, the review indicates that too little use is being made of performance targets in incentive contracts, due to the inexperience of our negotiators and to the need for much closer collaboration between technical and procurement personnel in defining performance objectives," he told the Congressmen. "The review also shows that sharing arrangements are still too conservative to achieve the benefits of superior rewards for good performance and severe penalties for poor performance."

Regarding the inexperience aspect of the problem, Morris indicated that longer tours of duty will be standard for procurement officers in the future.

Commenting on general progress in procurement and contracting, Morris said DOD has identified a number of specific problems which will be rectified. For one thing, he said, there will be a relaxation of detailed contract administration controls (such as requiring prior approval for overtime work). He said DOD is anxious to give contractors more latitude in this respect. ■

LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

The selection of Grumman to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon, opens a new chapter in the conquest of space. Boosted by a three-stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface.

Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all times. Current requirements are detailed on the next page. We invite your inquiry on the attached inquiry form or by personal resume to Mr. A. M. Williams, Technical Staff Engineer, Dept. GR-86.

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Propulsion Analysts—With ability to set up programs, and analyze complex propulsion problems involving liquid rocket systems. A degree in Engineering, Physics, or Mathematics plus direct experience with IBM 7090 or 1620 is required. Special experience with propellants, rocket tests, or flow systems is very desirable.

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Temperature Control Engineers—BS or MS and 2 years experience to handle space vehicle temperature control system analysis. Should have background in radiative heat exchange and thermal coatings as applied to passive and active temperature control systems.

Senior Heat Transfer Engineers—BS or MS with minimum of 5 years training and experience in structural heat transfer analysis is required. Will develop IBM programs and other analytical tools as needed to handle complicated configurations and end condition for space vehicle structures and propulsion systems. Must be capable of determining temperature distributions and recommended heat transfer configurations for initial structural designs and the detailed analyses, and test verification work to complete the design.

Structural Designers—BS in ME, CE, AE or equivalent with a minimum of 5 years experience in layout and design. Familiarity with materials and fabrications for space vehicles, and hydrofoil boats. Ability to perform preliminary structural analyses and coordinate priority structure with manufacturing and purchasing departments. Openings also available in preliminary design for experienced creative structural designers.

Mechanical Design Engineers—BS in ME, CE or AE with a minimum of 5 years experience in mechanical systems design, preferably familiar with aerospace design practices. Background should cover one or more of the following areas: mechanical linkages and their motions analysis; structural design of mechanical components; determination of power requirements and selecting of power supply; shock attenuation devices; wheels, brakes, anti-skid and steering devices and interpretation of military specifications. Duties: Assist in the formation of Aerospace Alighting Gear System concept and in the detail design of the overall system and its components. Also, establish the Lunar Landing System configuration and participate in the design of the system; design for stowage, extension and erection of the system in space and lunar environment; establish test requirements for the system in space and lunar environment; study and establish landing energy absorption requirements and medium compatible with space and lunar environment.

Aerospace Environmental Control & Life Support Systems Engineers —BS in ME, Chemical Eng., or EE, with a minimum of 2 years fluid mechaincs and/or thermodynamics experience in analysis, design, development, testing, installation for aircraft and space vehicles in one or more of the following areas: ENVIRONMENTAL CONTROL (Cabin, Equipment, Pressure Suit-cooling, heating, pressure, humidity controls); LIFE SUPPORT (Stored, Regenerative, Ecological Systems-CO_2, toxic gases, odor and moisture removal); CRYOGENICS (Storage, Supply, Temperature and Pressure Controls); TESTING (Development, Qualification, Functional Pre-flight).

Crew and Equipment Integration Design Engineers—BS in ME, AE or CE with experience in crew design, geometry, integration of display and control philosophy; typical uses of electronics systems with the analytical approach, working with Human Factors and Systems designers to the actual hardware. Must have a working knowledge of secondary control systems and power controls; be knowledgeable in the design, layout arrangement of high density equipment installation to meet rigorous vibration, thermal, structural and accessibility requirements.

Weight Optimization Engineers—To originate and contribute to the development of practical minimum weight design, to conduct trade-off studies for vehicle optimization and to carry out weight control during design of aerospace structures and systems. BS and 5 years aerospace experience within your specialty and general engineering competence are required.

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Background and experience (Brief resume of experience, recent history of employment)

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Technical Countdown

ELECTRONICS

Mars-Probe Subsystems Under Way

Flight command subsystems are now being developed for the Jet Propulsion Laboratory's first Mars probe by Motorola's Western Military Electronics Division, according to company officials at the Phoenix facility. The digital command unit, including extensive operational support (ground) equipment, will be an advanced version of the command flight hardware aboard the successful *Mariner* Venus probe.

Laser AFC Developed

The output of a laboratory laser has been controlled to within three kc of the frequency of a second laser by means of a new automatic control developed by TRG, Inc., in Syosset, N.Y. Scientists there stress that achieving such relative frequency stability (1 part in 10^{11}) demonstrates the practicality of optical communications using heterodyne techniques. In the TRG approach, the data signal is amplified in direct proportion to the increase in noise; thus, optical heterodyne detection effectively provides noise-free signal amplification. Reflector separation in the TRG laser is adjusted by applying a voltage to a piezoelectric transducer. Frequency control then is reduced to that of a conventional negative feedback loop that provides a correction voltage proportional to the difference between the two laser frequencies. The research is partially funded by the Air Force.

LaF_3 Crystal Lasered by Philco

In a continuing R&D effort to design more compact and higher-efficiency lasers for mobile ground and space applications, Philco Corp. has successfully produced large laser crystals of lanthanum trifluoride. To avoid the high concentration of lanthanum-oxide precipitates that usually occurs in such crystal growth, scientists effected growth in "active ambient gases." So far, crystals measuring up to ¼ in. dia. x 1 in. long have been produced with varying concentrations of neodymium doping.

Clutter-Cutter Rides Again

Bulova Watch Co.'s miniature electronic timer used for on-board turn-off of satellite transmitters and experiments will get another ride into space this month aboard the NASA RCA *Tiros-VII,* slated for launch June 18 from Cape Canaveral. The satellite silencer, designed around a modified version of the firm's accutron electronic wrist watch, has been used aboard *Explorers VII* and *XI, Telstar I* and *II, Tiros VI,* and *Syncom I.* The device, which requires only eight-millionths watt power, is also slated for future *Syncom, OAO* and *Nimbus* satellites. Bulova says the current three-year battery operation will be improved soon. Five-year measurement capability is now available using additional outside power, the company claims.

ADVANCED MATERIALS

Space Lubricant Tested Under High Loads

Bearings and gears impregnated with tungsten diselenide will operate continuously for more than five years in lightly loaded space applications, say Westinghouse scientists after a series of environmental tests. The lubrication system protected parts for periods in excess of 200 hours under unit compressive stresses up to 200,000 psi on the bearings and 120,000 psi on the gears. Temperatures in the vacuum tests ranged from —320° to 450°F. The WSe_2 is held in silver and copper matrices together with small amounts of polytetrafluorethylene to assist in dry film formation. The heavy load performance justifies the light-load space application claim of five years, say company developers.

Light-Sensitive Glass Developed at AO

Researchers at American Optical Co. have come up with an optical material capable of rapid darkening under the stimulus of light, and returning to a transparent state when the light is removed. The darkening effect is completed in less than 40 millionths of a second, while the reversal varies because of composition. AO specialists say applications might include welder's masks and manned spacecraft windows. The development is still in the research stage.

Control Formula for Percussive Welds

Bell Telephone Lab scientist James Coyne predicts less than one defective connection in 10,000 through proper continuous welding controls in the percussive welding of wires to terminals. To control the process, Coyne advocates measuring the duration of the arc and the approach speed of the feed wire for each weld. A device can be set to reject welds automatically if arc duration is too long or too short. Coyne has developed a formula to determine the arc-time ranges for high-quality welds between terminals and various types and gauges of wires.

Ablative Coatings Perfected by Autonetics

Ablative coatings aimed at the protection of electronic components from rocket engine heat are in development at North American Aviation's Autonetics Div. In one test the materials held the backside temperature of a 0.1-in.-thick aluminum plate to 160°F. under 60 seconds exposure to 2000°F. The ablative coating was 0.15 in. deep. The materials are basically low-temperature-curing silicone polymers, bisphenol-A epoxy cement and either macerated cork or phenolic micro-balloons for the filler.

PROPULSION

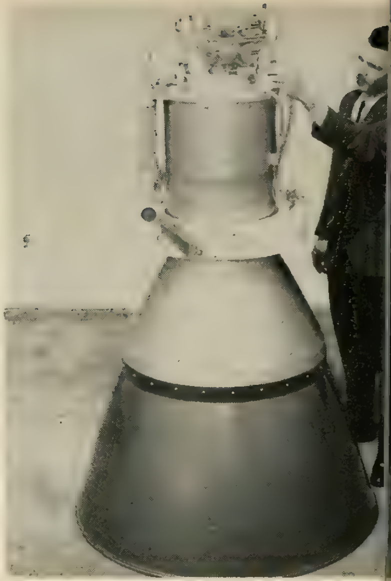
Marquardt Markets Roksonde Rocket

Development testing of a company-sponsored sounding rocket system (Roksonde) is completed and Marquardt Corp. says the unit is available for operational meteorological applications. The 30-lb. system, equipped with a miniaturized instrumentation package, reached an altitude of 200,000 ft. in a recent test. Data was transmitted during the payload's 20-min. descent while radar tracking of its metallized chute provided wind direction and velocity information. Temperatures ranging from —70° to 160° F were sensed between altitudes of 200,000 and 80,000 ft. and high-altitude winds were tracked up to 220 mph. A standard GMD-1 meteorological ground station was adapted for the tests.

STL Wins Parallel LEM Descent Engine Contract

TRW subsidiary's powerplant achieves high combustion stability through unique flow-control and injection concept

by John F. Judge



FULL-SCALE mockup of descent engine.

A PARALLEL development contract for the Lunar Excursion Module's throttleable descent engine will go to Space Technology Laboratories, Inc., subsidiary of Thompson Ramo Wooldridge, Inc.

North American Aviation's Rocketdyne Div. is developing a gas-injection throttleable engine under a contract awarded last February from LEM prime Grumman Aircraft Engineering Corp., and NASA's Manned Spacecraft Center, Houston.

One of the two technical approaches will be selected for development completion early in the program.

Grumman announced the STL choice May 28 without disclosing the contract amount—but the entire program is expected to run just over a year.

The contract is STL's second propulsion success in a week. The firm has a letter contract from NASA's Jet Propulsion Lab for backup development on the *Surveyor* vernier engine.

Both STL engines are based on new concepts in propellant flow control and injector design. Through these innovations, the STL deep-throttling, bi-propellant engine:

—Reaches combustion efficiencies of 98% of theoretical or more at maximum thrust.

—Maintains propellant mixture ratio control within 1% over a complete throttling range of about 60 to 1.

—Has passed 582 seconds of total firing time in recent tests while duplicating the thrust schedules deemed typical of that required for the LEM landing. This total time is two minutes more than anticipated for an actual landing.

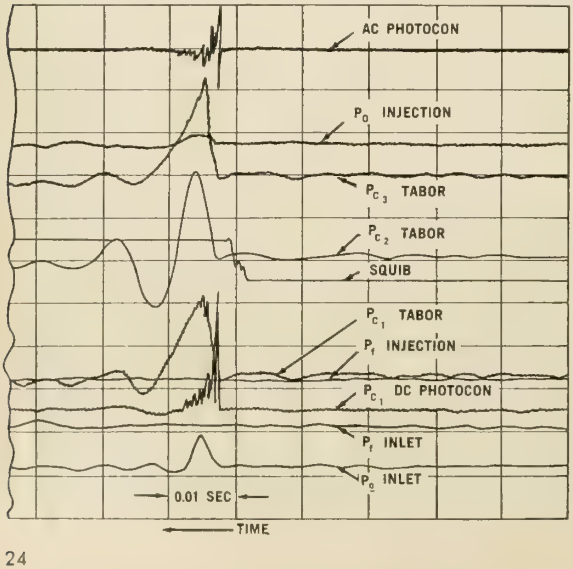
—Has automatically damped out artificially induced tangential instability in the combustion chamber during a firing and returned to normal operation within 10 milliseconds.

- **Separate but equal**—The two unique components—a variable-area cavitating venturi valve and a variable-area coaxial tube injector—handle the flow-control and propellant-mixing functions in the STL engine. The operation is so performed as to isolate these generally conflicting functions from each other.

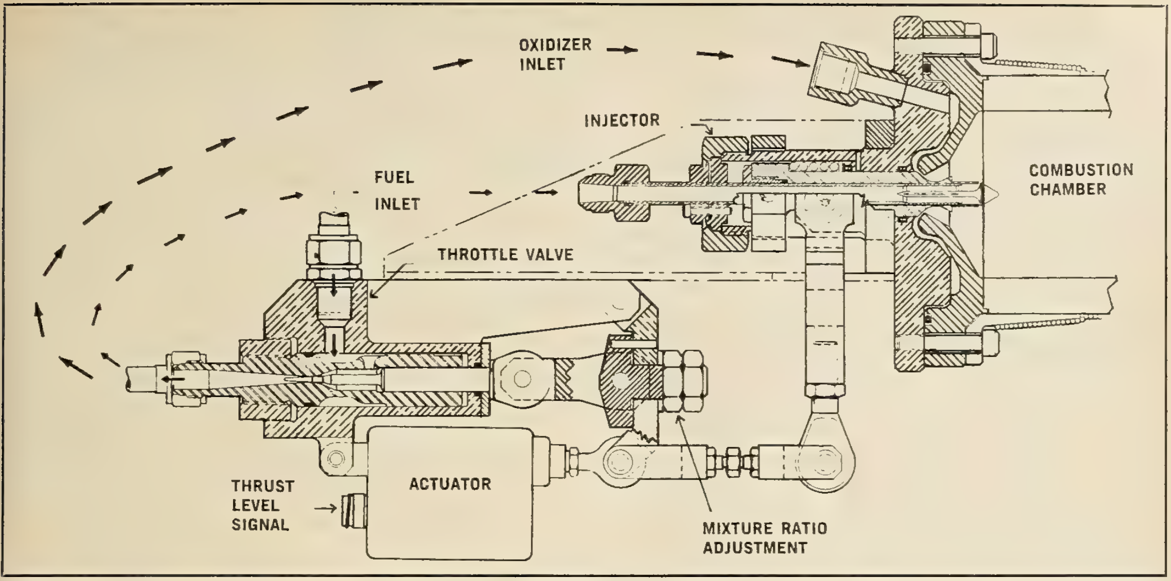
The STL cavitating venturi concept hydraulically decouples flow control from the rest of the system, ensuring that the flow rates of the two propellants—and thus the mixture ratio—are insensitive to variations in down-stream pressures resulting from either injector orifice changes or chamber pressure fluctuations.

This is accomplished by the cavitation phenomenon—the formation of local cavities or bubbles in a liquid by reduction in the total pressure of the liquid. These two cavitating valves control the amounts of propellants going to the injector so well, says STL's Ben Davis, Manager of Propulsion Applications, that the mixture ratio will not vary more than 1% from that desired over the complete throttling range.

In effect, continues Davis, the engine is more reliable and stable than non-cavitating powerplants because it eliminates a tendency to chugging or low-frequency instability.



ENGINE'S damping ability is shown on traces from induced combustion instability. The d-c photocon spike shows immediate return to operating pressure

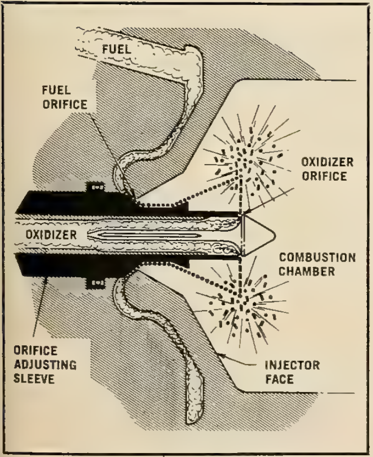


THE CAVITATING venturi valves are located just below fuel inlet on left in this early schematic. These flow-control units are isolated from coaxial injector in function, but are mechanically linked, and operated by a single actuator.

The STL injector design calls for only one moving part—a sleeve—while controlling just the propellant velocities and impingement angles. The flow-control function takes place at the cavitating venturi valves.

The sleeve varies both the oxidizer and the fuel orifices to correspond to a given propellant flow rate, maintaining maximum mixing velocities. Keeping these velocities at an optimum level while the thrust varies is essential to high performance.

The injector is mechanically linked to the dual throttle valves. Both are handled with a single actuator. The injector design allows uniform symmetrical mixing in the combustion chamber—eliminating at least one major source of combustion instability. This feature also permits extremely long burning times on ablative chambers with what STL calls "amazingly uniform" throat erosion.



IN OPERATION, the coaxial injector produces a sheet/cone mixing effect with the oxidizer kept from walls.

- **Planned explosions**—The instability test at STL consisted of exploding an 18-grain charge inside the combustion chamber after the engine reached normal operating chamber pressures. The charge set off a first tangential or spinning mode of instability.

The peak spike shown in the traces on page 24 represents an increase of approximately 200 psi over normal engine pressure. The computed value for the first tangential is 1,750 for the LEM chamber. The trace shows a number of pressure oscillations at approximately this frequency being triggered by the explosion.

Four such tests have been conducted by STL. The photocon gauges used were flush-mounted and have a frequency response greater than 10,000 cps. The trace of photocon 1 is a dc record and photocon 2 is a record of the ac component of pressure only. The engine was operating smoothly at a chamber pressure of 100 psia.

The induced-instability tests demonstrate the dynamic stability of the engine, says Davis, and it means that any start transient variations or main stage local combustion "triggers" cannot cause engine instability and then failure.

- **Developmental history**—In development about two years, the STL engine is the result of a corporate decision to enter the propulsion field aiming at deep-throttling space applications.

The flow/injection isolation concept has resulted in flat performance curves over variable thrust ranges. This differs from the typical liquid engine feature of optimum performance at a given thrust level, but a fall off as the thrust varies. The STL engine gives a thrust performance above 95% even at the 0.1 thrust level.

STL has conducted an extensive company-sponsored development effort in 500- and 5,000-lb. thrust, throttleable engines. The instability tests were conducted at the firm's facilities. The Air Force Rocket Propulsion Lab at Edwards AFB tested the 5,000-lb. unit.

The 582-second ablative chamber test was conducted at Edwards. ■

UNIFORM EROSION characteristic of engine is visible on this 500-lb. thrust nozzle after ablative "grin" removal.

What's going on at Republic Aviation?

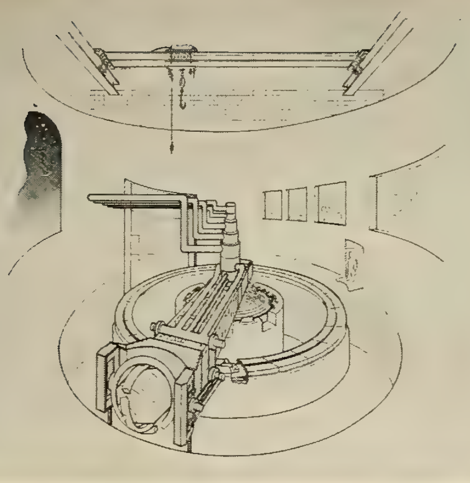
Apollo Space Suit life-support studies; a Mach 2/VTOL/variable-geometry aircraft design; fluid-power systems for a supersonic transport; 77 parts for NASA's Saturn; studies for the Synchronous Meteorological Satellite; re-entry capsules for NASA's Project Fire; the F-105D and F-105F (two-place) Mach 2 fighter-bombers; guidance for the Bullpup missile; training simulators and control systems for submarines; studies for the Advanced Orbiting Solar Observatory; electronic ground support equipment; the Bikini Photo Drone; the magnetic-induction nuclear gyro... and too many other aerospace and hydrospace projects to include

And who's doing it?

Eighteen thousand people, including weapon system analysts, mathematicians, oceanographers, nuclear physicists, biochemists, radiobiologists, physicians, metallurgists, microbiologists, plasma physicists, astronomers, astrophysicists, psychologists, physiologists, astrobiologists . . . and chemical, cryogenics, communications, radar, guidance, orbital mechanics, human-factors, propulsion, acoustics, design criteria, reliability, hydraulic, flight dynamics, structural, applied mechanics, nuclear, computer, hydrodynamic, thermodynamic and aerodynamic engineers.

Republic Aviation Corp.,
Farmingdale, L.I., N.Y.

3-Man Centrifuge To Be New Ames Research Nucleus



Artist's drawing of NASA's proposed Ames centrifuge.

by Robert Lindsey

MOFFETT FIELD, CALIF.—NASA's Ames Research Center is studying recently-submitted proposals for a three-man centrifuge which will be the heart of a new $9.8-million Space Flight Guidance Research Facility.

The SFGRF is designed to simulate within terrestrial limits a complete space flight from take-off to land—or selected portions of a mission—providing acceleration, motion, environment and tasks for crew and equipment during take-off, mid-course flight, reentry and landing under normal and abort conditions.

In a second function, it will be used for physiological research to determine effects of various combinations of acceleration, motion and environment on test pilots. The facility is expected to be completed within 21 months after work begins.

Two interchangeable capsules will be used, one for simulation of missions and one for higher-acceleration physiological research.

The capsule in use will be suspended in a three-axis, servo-positioned, gimbal system and a vertical travel mechanism mounted at the end of a rotating 50-ft. boom that will be driven by an adjustable-speed, 22,100-hp motor drive system.

Ames has suggested to prospective bidders that an air bearing be used as a cushion on the track to support the weight and vertical thrust component of the capsule.

The system will be driven by computers programmed to simulate all stresses of spaceflight except weightlessness, and will respond to the commands of the crew.

- **Criteria**—These are the basic design requirements of the system:

—Capsule No. 1, to be used for mission simulation, will be essentially an *Apollo*-type capsule with space for up to three crewmen, instruments, life-support equipment, vibration equipment and detachable panels to simulate capsule wall temperatures.

It will operate at levels up to 20 g. Payload will be 3,000 lbs. and will be shaped either as a 13-ft.-dia. sphere or a cylindrical, conical ended configuration.

—Capsule No. 2, for physiological research, will have only one crew station and be capable of operating at up to 50 g with a 1,000-lb. payload. It is to be a windowless cylinder at least eight feet wide and six feet long.

With the arm rotating at up to 20 g, roll, yaw and pitch axis must have these characteristics:

	Velocity	Acceleration
Roll	*8 radians/sec.*	*18 radians/sec.^{2}*
Yaw	*2 radians/sec.*	*6 radians/sec.^{2}*
Pitch	*2 radians/sec.*	*6 radians/sec.^{2}*

Displacement: unlimited.

When capsule No. 2 is operated between 20 and 50 g, gimbals will be locked in minimum stress position.

For vertical travel, the normal operating stroke will be four feet, with cushioned overtravel. The capsule will travel vertically at 16 fps downward and 11.3 fps upward.

The centrifuge will accelerate at a rate of 7.5 g per second to a maximum of 20 g, maintain this velocity for up to 10 minutes, and decelerate at 7.5 g per sec.

Capsule No. 2, with gimbals locked in position after reaching 20 g, will have an onset acceleration rate of 7.5 g per sec. from 20 g to 50 g, and maintain the 50 g rate for one minute, then decelerate at 7.5 g per sec.

The system will be capable of decelerating from 60 fps to zero velocity in .20 sec.

For simulating take-off and other vibrations, the simulator will be capable of plus or minus one g in the X, Y and Z axis using capsule No. 1 in a 10-g field. Capsule No. 2 crew station will be subjected to maximum vibration of plus or minus two g in the X and Y axis with the capsule operating in a 14-g field, and vibration in the Z axis will be plus or minus six g in a 10-g field.

- **Environment**—The system will have these environmental characteristics:

Pressure: Simulated pressure altitude over a range from sea level to 100,000 ft., achieving 30,000-ft. altitude in one minute and 100,000 in 10 minutes. For simulated descent, the system will be capable of descending from 100,000 ft. pressure altitude to 40,000 in five seconds.

Gaseous environment: Nominal capsule operating conditions will be within three psi and sea level pressure, using pure oxygen or mixtures of oxygen and other gases. Oxygen partial pressure will be regulated from 760 mm Hg to 80 mm Hg within one per cent.

Thermal environment: Cabin air temperature will be adjustable by command from —40°F. to 200°F. Wall temperature will be controlled by external equipment, and only when the boom is stationary and gimbal rotation is limited to ±180° for yaw and ±90 for roll and pitch. Wall temperature range will be the same as for the air. An umbilical connection will supply refrigeration and electrical heating for the walls.

Water vapor pressure of the capsule air will be controlled within the range of 5 mm Hg partial pressure of the vapor up to a dew-point temperature of 150° F at altitudes between sea level and 30,000 ft.

NASA stipulated the SFGRF will be engineered and built on a fixed-price basis. NASA PERT will be used. ■

Materials Problems Hobbling Gaseous-Core Nuclear Rocket Concept

Single-cavity-vortex-type reactor declared marginal by NASA researcher; other approaches called superior

A NASA SCIENTIST has thrown cold water on what had been regarded as one of the more promising concepts of advanced nuclear rocket propulsion—the single-cavity vortex gaseous reactor.

He simultaneously delivered a discouraging report on several proposed alternative approaches. But he sounded an encouraging note for a few other ideas which he said may pay off with high performance despite the overall problems with gaseous-reactor engines.

Robert G. Ragsdale, of the Lewis Research Center in Cleveland, has conducted extensive heat-transfer studies and hydrodynamic evaluations of gaseous-core reactors. He concluded that:

- The performance potential of the single-cavity vortex reactor, in which all the propellant must diffuse through the fuel-rich region, is less than that of solid-core reactors.
- One alternative scheme—using increased vortex length by means of a number of channels or a matrix—might give higher performance but would create severe wall-cooling problems and subsequent degradation of specific impulse (I_{sp}).
- A second alternative, wherein only a small fraction (perhaps 1%) of the propellant passes through the fuel-rich region while the remainder of the hydrogen is heated by thermal radiation, might achieve reactor thrust-to-weight ratios of 1 to 10, if it is limited only by the separation process and reactor criticality.

Ragsdale emphasized that his conclusions were primarily based on the thrust-to-weight ratio as a measure of performance, and applied to the single-cavity vortex gaseous reactor.

The single-cavity vortex concept has been viewed for some time as a good candidate for replacing presently used solid-core reactors, such as the Kiwi series, but doubts about its value have arisen recently and are now confirmed by the Lewis evaluation. (The conclusions are contained in NASA Technical Note D-1579.)

- **Other concepts promising**—Despite the fading allure of the single-cavity vortex design, other methods of using the advantages offered by gaseous-core reactors are still being sought by the joint AEC/NASA Space Nuclear Propulsion Office (SNPO), managed by Harold B. Finger.

The basic concept of the gaseous-core reactor is that of a cavity or other void design into which is pumped a hydrogen/uranium mixture in gaseous form. The reactor is externally moderated and reflected. The reactor is made critical by increasing the pressure of the fissionable gas. Heat then generated by the fissioning gas raises the temperature of the hydrogen through direct mixing, and the heated mixture is ejected from the nozzle.

Francis C. Schwenk, Chief of the Advanced Engine Branch of SNPO, told MISSILES AND ROCKETS that Ragsdale's findings do not mean the entire gaseous reactor concept has suffered a setback—only specific portions of it.

He pointed out that there may be some promise in a system which diffuses a small portion of the hydrogen propellant through the fuel-rich area and heats the main bulk of the propellant by thermal radiation. This method, he said, could have potential because technological progress may provide some key solutions to the problems it presents.

Schwenk also described the coaxial-flow gaseous-core nuclear reactor as one approach that appears to offer some hope of high performance. The difference between the vortex and the coaxial types is that in the vortex reactor the hydrogen/uranium mixture is injected tangentially from the walls, while in the coaxial reactor injection would be from the ends of the cavity.

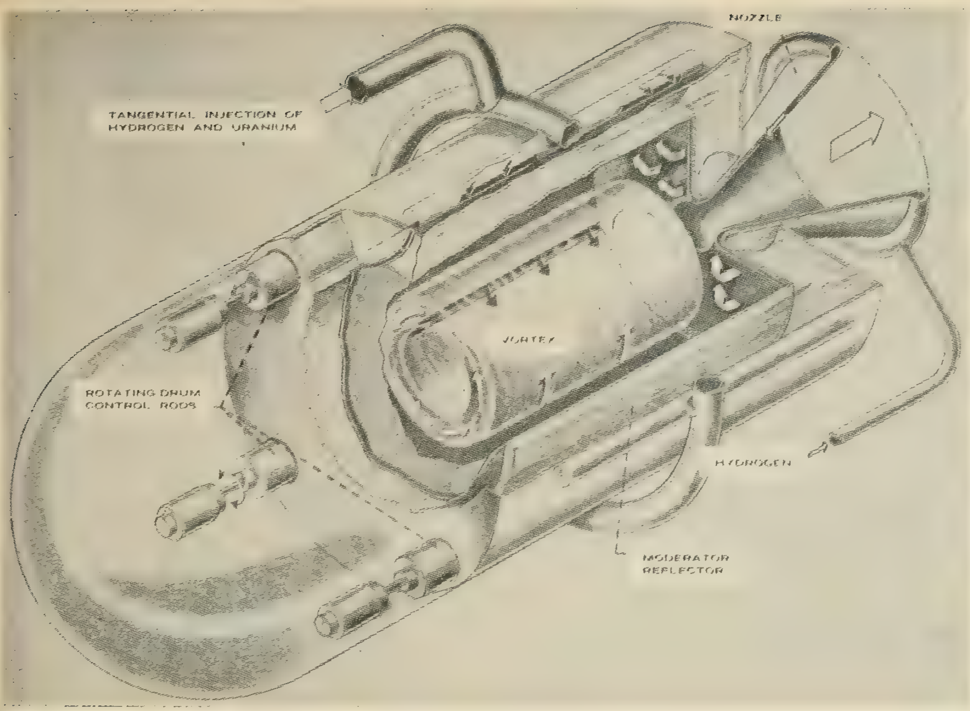
The vortex concept involves swirling the gas mixture so that the heavier uranium atoms are swept toward the walls by centrifugal force, and the hydrogen must diffuse through the resulting uranium cloud in order to escape from the nozzle. The difficulty, in addition to high-temperature problems, is the low flow rate this scheme requires. High flow rates would mean that the centrifugal force would be overcome and the uranium cloud would be exhausted from the reactor.

In the coaxial flow reactor, the uranium and hydrogen are injected in separate streams from the head of the reactor, with the uranium at a lower velocity than the propellant in order to maintain a reasonable hydrogen/uranium weight-flow ratio. The idea in both concepts is to lengthen the dwell-time of the uranium.

Schwenk cautioned against assuming the thrust-to-weight ratio to be the only significant performance parameter. "If electrical engines were judged on this basis alone," he said, "we wouldn't consider them for very long. The specific impulse level must also be considered, as well as other features of the system."

The significance of Ragsdale's findings is that, for the amount of I_{sp} attainable from the system, the thrust-to-weight ratio is not good enough. For each I_{sp} level and mission profile, there is a range of acceptable thrust-to-weight ratios.

- **Vortex design flaws**—A number of specific drawbacks were found in the single-cavity vortex method during Ragsdale's evaluation. The Lewis Center scientist said that for a typical interplanetary mission, a specific impulse of 3,000 secs. from a gaseous reactor would require a powerplant thrust-to-weight ratio of 10^{-2} in order to meet the same


NOZZLE
TANGENTIAL INJECTION OF HYDROGEN AND URANIUM
VORTEX
ROTATING DRUM CONTROL RODS
HYDROGEN
MODERATOR REFLECTOR

IN SINGLE-CAVITY vortex gaseous nuclear rocket, mixed uranium and hydrogen is injected tangentially. Uranium is swept toward the outside by centrifugal force. Hydrogen is forced through "cloud" of uranium and ejected as hot gas.

performance requirements of a solid-core nuclear rocket operating with an I_{sp} of only 1,000 secs. The level of 3,000 secs. for the single-cavity vortex gaseous reactor is considered highly optimistic.

The highest performance, measured in terms of thrust-to-weight ratio, achieved by the Lewis scientist was 1.2×10^{-3}, not enough to equal the solid-core reactor performance.

The gaseous-core reactors have been considered desirable in general because of the potential of high I_{sp} through extreme temperatures, inasmuch as no solid-fuel elements would be present to place a limitation on temperature. Even this advantage, however, has been denied by Ragsdale. He points out that wall temperatures surrounding the cavity will in themselves constitute a limiting factor.

Assuming that 10% of the combined effects of nuclear and thermal radiation is deposited in the cavity wall, Ragsdale points out that this must be held to a minimum through hydrogen cooling. If it is further assumed that the hydrogen enters the reactor cavity at 5,000°R, conditions result in a maximum possible exhaust temperature of 15,000 to 20,000°R, depending on pressure, and a subsequent I_{sp} level of about 3,000 seconds. The only possibility of getting better I_{sp} Ragsdale said, is to use a radiator to dispose of the additional solid-region heat. This includes the nozzle.

That portion of the total power generation (estimated at 10%) which heats the cavity walls must be removed by cooling hydrogen, thus causing an enthalpy rise in the hydrogen in the solid region, which cannot exceed the total rise possible in a solid-core reactor. This, then, fixes the maximum possible enthalpy gain available to the hydrogen in a gaseous-core system.

- **Mixture ratio**—Apart from the basic problems of the hydrogen-uranium separation process and heat transfer, the evaluation pointed up the difficulty of propellant-to-fuel flow ratio. An upper limit to this ratio between uranium and hydrogen will be established by hydrodynamic and nuclear considerations. If the ratio is too large, Ragsdale declares, fuel concentrations necessary for criticality will not be achieved.

The lower limit of propellant-to-fuel ratio is concerned with more than the consumption rate of uranium or the achievement of criticality. As the fuel-to-hydrogen atom ratio increases, the average molecular weight of the exhaust gas—being a mix of heavy uranium atoms and light hydrogen atoms—increases, causing specific impulse to drop off. The acceptable level of this dropoff will determine the limit on the mixture ratio.

- **Performance capability**—Giving some hypothetical system figures for his calculations, Ragsdale pointed up the various features of a laminar-flow reactor. Laminar flow showed better performance than turbulent flow:

—Hydrogen-to-fuel flow rate ratio: 100.

—Average uranium density, particles/cc: 0.46×10^{18}.

—Vortex outer radius, feet: 5.5.

—Reactor cavity length-to-diameter ratio: 2.

—Specific Impulse, seconds: 3,000

—Thrust, pounds: 530.

—Reactor thrust-to-weight ratio: 1.23×10^{-3}.

- **Alternate systems**—Possible alternate methods of approaching the design of a gaseous core reactor were not particularly promising, Ragsdale said. He noted that any alternative must provide an increase in thrust of at least two orders of magnitude—either by increasing the effective length of the reactor through a tube bundle or matrix, or by flowing only a small portion of the propellant through the fuel-rich area so that the major portion is heated by thermal radiation.

In the first of these methods, Ragsdale said, there would be severe heating problems in all the wall surfaces involved, as well as the inlet headers, exhaust ducting and other solid portions. For the second method, he also foresaw difficulties, somewhat less severe, in heat transfer. Here, he said, thrust-to-weight ratio between 1 and 10 is possible.

Ragsdale says his primary conclusion—that a single-cavity vortex gaseous reactor in which all the hydrogen must diffuse through the fuel region—is based on a consideration of several effects previously treated separately by other researchers. ■

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The Industry Week

In the Courts

The Ohio Court of Appeals has issued an injunction in the case of Wohlgemuth vs. B. F. Goodrich Co. prohibiting Donald W. Wohlgemuth, a former Goodrich spacesuit expert, from working for any space competitor of that company. If upheld in a likely U.S. Supreme Court appeal, the decision could set a significant precedent for future missile/space industry employment practices.

Wohlgemuth, until recently manager of Goodrich's spacesuit department, accepted a similar position with International Latex Corp., a Goodrich competitor in spacesuit development. The Ohio court found that in so doing Wohlgemuth carried with him Goodrich trade secrets, any disclosure of which would be a "breach of faith and reprehensible to a court of equity." Because he was hired to do similar work by Latex, the court further found that a substantial "threat of disclosure" did exist.

Mergers and Acquisitions

Discussions between General Precision Equipment Corp., Tarrytown, N.Y., and Radiation Incorporated, Melbourne, Fla., until recently expected to result in GP's purchase of RI, have been ended. . . . *CES Electronics Products, Inc., San Diego, Calif., has been purchased by a group headed by Russell G. Greenbaum, formerly president of Nacimco Products and director of Microdot Scientific Development Center, San Diego. CES produces amplifiers, notch-filters, logarithmic attenuators, and inspection test equipment.* . . . MICON Inc., Dallas electronics firm, has absorbed the operations of Communications Facilities Co., Inc., also of Dallas. CFC has considerable experience in antenna arrays and attendant transmission lines. . . . *Sparton Corp., Jackson, Mich., has acquired Colvin Laboratories, Inc., East Orange, N.J., from Avien, Inc., Woodside, N.Y. Transaction was made to extend electronics capabilities of SC in its missile, satellite and undersea programs currently under way at SC facilities in Jackson, Albuquerque, N.M., and London, Ont., Canada.* . . . The boards of directors of Emerson Electric Manufacturing Co., St. Louis, and Rantec Corp., Calabasas, Calif., have approved plans for a merger. Actual merger pends approval of stock holders of both companies. Rantec designs, develops, and produces microwave devices, electronic instrumentation and antennas. Emerson produces electric drives and a wide range of industrial instrumentation and automation equipment.

Industry Facilities

Kelvin Corp., Van Nuys, Calif., has increased size of its Fajardo, Puerto Rico, facility to 7,000 sq. ft. A clean-room area in the addition provides temperature and humidity control for work on the firm's precision wire-wound resistors and resistance networks. . . . *Construction on Jet Propulsion Laboratory's $2-million, 80,000 sq.-ft. Space Flight Operations Facility being built in Pasadena, Calif., has reached the half-way point. The building is expected to be ready for occupancy in late September. SFOF will serve as the central point for collecting and analyzing data received from deep-space-probe vehicles. An interior highlight of the three-story facility will be a mezzanine gallery where launchings and other activities may be viewed on a massive television command screen.* . . . Avco Corp., Cincinnati, has opened a joint engineering and development center for its Aerospace Structures and Electronics Divisions in Huntsville, Ala. The 5,500 sq.-ft. facility will house space development engineers and technicians from the two divisions, equipment-fabrication workers, laboratory equipment and an IBM 1620 computer. . . . *International Resistance Co. will start construction of a $2.5-million, 72,000-sq.-ft. advanced R&D center in Worchester Township (near Norristown), Pa. in March, 1964.* . . . Lockheed Missiles and Space Co. has broken ground for an R&D center in Huntsville, Ala. The first 50,000 sq.-ft. facility is expected to be finished next October. Provision has been made in the master plan for an eventual total of 750,000 sq. ft. . . . *Recently completed liquid production facilities have been placed on stream at Huntsville, Ala., by Union Carbide Corp.'s Linde Div. Expansion adds 190 tons per day of liquid oxygen and nitrogen capacity, more than doubling former capacity.* . . . General Applied Science Laboratories, Inc., aerospace and electronics research and manufacturing company, has leased an additional 20,000-sq.-ft. plant in Syosset, N.Y. to house expanded activities resulting from the recent consolidation of Lumatron Electronics, Inc., manufacturers of nanosecond oscilloscopes and other advanced electronic instrumentation, with GASL.

Representatives Named

Andrew Corp., Chicago, has opened a sales engineering office in Dallas to provide direct engineering and product assistance to the communication industry in the South and Southwest. . . . *Rockbestos Wire & Cable Co., Div. of Cerro Corp., has appointed Alan A. Shattuck, La Crescenta, Calif., as sales manager for northern California, Idaho, Montana, Oregon, and Washington and the trading areas of Reno, Nev., and Salt Lake City, Utah.* . . . Arnold Magnetics Corp., Pasadena, Calif., manufacturer of airborne solid-state power equipment, has named Ed Landa Co. as exclusive engineering sales representative for Los Angeles. . . . *Power Designs, Inc., Westbury, N.Y., manufacturer of power supplies, has appointed representatives for northern California and northern New York. The northern California territory has been assigned to Long & Associates, Redwood City. The New York representative is R.J.C. Associates, Liverpool.*

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SPACE DIVISION **CHRYSLER CORPORATION**

Circle No. 15 on Subscriber Service Card

contracts

AIR FORCE

$19,000,000—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for the manufacture of decoy subsystems to be carried by *Atlas "F"* and *Titan II* ballistic missiles.

$6,400,000—**Ets-Hokin & Galvin, Inc.,** San Francisco, for engineering, installation and testing of cable communications system for the *Minuteman* site at Warren AFB, Wyo.

$6,000,000—**Defense Electronics, Inc.,** Rockville, Md., for equipment for the Atlantic Missile Range.

$3,600,000—**General Dynamics Corp., Astronautics Div.,** for advanced research and development on ballistic re-entry system.

$1,500,000—**Geotechnical Corp.,** Garland, Tex., for further work on Vela-Uniform program.

Electro-Mechanical Research, Inc., Sarasota, Fla., for design, development building and calibrating of rocket-borne ultraviolet radio-meters (Undisclosed amount).

ARMY

$80,000,000—**Ling-Temco-Vought, Inc.,** Dallas, for research and development work on *Lance* missile.

$18,800,000—**Western Electric Co.,** Whippany, N.J., for design, development and fabrication of a multifunction radar device for *Nike-X.*

$4,200,000—**Sylvania Electric Products, Inc., Electronic Defense Laboratories Div.,** Mountain View, Calif., for electronic warfare research and development.

$2,800,000—**International Business Machines Corp.,** Poughkeepsie, N.Y., for production of electronic equipment.

$2,700,000—**General Telephone and Electronics Corp.,** Waltham, Mass., for continued development of a weapons-locating radar system.

$2,300,000—**Raytheon Co.,** Lexington, Mass., for work on *Hawk* surface-to-air missiles.

$2,000,000—**Sperry Rand Corp., Sperry Utah Co.,** Salt Lake City, for launcher, general support, equipment components, and services for the *Sergeant* missile system (10 contracts).

$1,800,000—**Collins Radio Co.,** Richardson, Tex., for ground communications equipment.

NAVY

$21,200,000—**Martin-Marietta Corp.,** Orlando, Fla., division, for production of *Bullpup* ASM-N-7A weapon system.

$6,000,000—**Westinghouse Electric Corp.,** Washington, D.C., for engineering services for installation of *Polaris* launch equipment.

$3,600,000—**General Precision, Inc., Librascope Div.,** Glendale, Calif., for fire-control systems and related equipment for *ASROC* missile system.

$3,500,000—**Raytheon Co.,** Lexington, Mass., for maintaining schedules for *Sparrow III* missiles.

$3,200,000—**General Precision, Inc., Librascope Div.,** Glendale, Calif., for fire-control systems for Fleet Ballistic Missile.

$2,100,000—**Hicks Corp.,** Asheville, N.C., for guided missile boosters.

$1,900,000—**Vitro Corp. of America,** Silver Spring, Md., for engineering services for surface-launched guided missiles.

$1,600,000—**Texas Instruments, Inc.,** Dallas, for production of guidance and control equipment for missile system.

$1,200,000—**Philco Corp.,** Philadelphia, for guidance and control components for *Sidewinder 1A* air-to-air missile.

$505,187—**Vitro Corp. of America, Vitro Laboratories,** Silver Spring, Md., for torpedo equipment, reliability studies and engineering work on the *Tartar* guided missile weapon system (3 contracts).

$418,000—**Elgin National Watch Co.,** Elgin, Ill., for Mod 2 fuze for *Sidewinder 1A.*

$200,000—**General Applied Science Laboratories, Inc.,** Westbury, N.Y., for continuation of research in the physics of re-entry for the *Polaris* missile.

$268,800—**G. W. Galloway,** Baldwin Park, Calif., for guided missile warhead.

$182,700—**Martin Marietta Corp.,** Orlando, Fla., division, for research and development on *Bullpup* training missile.

$98,900—**Armour Research Foundation of the Illinois Institute of Technology,** Chicago, for research and development on the chemical conversion of waste to electrical energy.

NASA

$6,700,000—**North American Aviation, Inc.,** for *Gemini* paraglider landing system program.

$4,500,000—**Federal Defense Systems, International Business Machines Corp.,** Rockville, Md., for integrated real-time computer complex at Manned Spacecraft Center.

$98,000—**Lockheed Aircraft Corp.,** for study of operations and logistics of *Manned Orbital Space Station.*

$68,400—**General Dynamics Corp., Electronics Div.,** Rochester, N.Y., for a study of magneto-acoustic information storage system.

$20,000—**McDonnell Aircraft Corp.,** for *Mercury-Atlas* spacecraft #15.

INDUSTRY

$2,200,000—**Control Data Corp.,** Minneapolis, from **North American Aviation, Inc., Space and Information Systems Div.,** for high-speed digital computers to check out Stage II of the *Saturn V* launch vehicle.

$1,000,000—**Lear Siegler, Inc.,** Santa Monica, Calif., from **Sperry Utah Co.,** for follow-up production of *Sergeant* missile guidance fin servos.

$399,000—**McCormick Selph Associates, Inc.,** Hollister, Calif., from **Martin Marietta Corp.'s Orlando Div.,** for exploding bridgewire systems components used on the *Pershing* missile.

Immediate openings in:

ADVANCE ENGINEERING

Aeroballistics . . . Aerothermo Mechanics (aerodynamic testing, analysis, stability and air loads; heat-transfer studies; thermodynamics of power systems and cryogenic storage; aerothermo research in theoretical gas dynamics, radiation physics, and computer programs.) Flight Mechanics (trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics and celestial mechanics.) **Future Systems Analysis . . .** mission analysis and planning, operations research, advanced program planning, human factors.

ELECTRICAL and ELECTRONICS

Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES

Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

MANUFACTURING

Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

PROGRAMMERS

Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

QUALITY CONTROL

Supervise and maintain reference of standards in mechanical systems, electrical systems, quality assurance and systems automation; evaluate instructions and test procedures and develop techniques for adapting digital computers for automatic checkout systems.

RELIABILITY

Develop analysis methods and techniques; analysis in electrical, mechanical, electro-mechanical, structural, propulsion, systems and other areas; evaluate program; recommend engineering changes.

STRUCTURAL, PROPULSION and RELATED ENGINEERING

Stress, structural dynamics, propulsion, cryogenics, aerodynamic loads, hydraulics, weights, materials, documentation, drafting, electro-mechanical component installation design, and development of computer solutions for all phases of structural and mechanical analyses.

SYSTEMS INTEGRATION

Mission planning, functional integration, design criteria and mission evaluation of space vehicle systems and subsystems and digital automatic checkout equipment.

SPACE DIVISION CHRYSLER CORPORATION

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Circle No. 3 on Subscriber Service Card

Lockheed T/M System May Set Trend

A PCM TELEMETRY data-processing system with integral magnetic core programming introduced recently at the National Telemetering Conference in Albuquerque, N.M., is being marketed by Lockheed Electronics Co.

Company spokesmen claim the equipment is indicative of a new trend toward more sophisticated and versatile data systems.

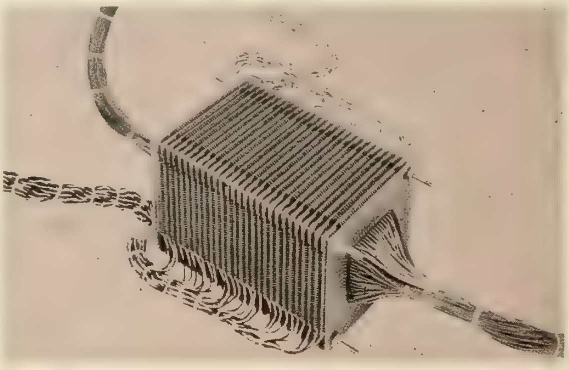
Built on a company-financed development program, none of the systems has yet been sold. Lockheed is hopeful, however, that the in-house program will give them a significant lead over competition.

The principal feature of the new system is high-capacity (4,096-word) core memory programming with both manual programming and punched paper tape entry methods. Up to four complete PCM formats can be stored in the memory. With built-in link switching, formats can be changed in microseconds. No relays are used in the switching. Another feature is elimination of patching errors by use of the paper tape program entry.

• **Buffer function**—The integral computer functions of the station have other advantages. For example, the unused portion of the memory is available as a computer input buffer. Also, the memory can be used for data limiting and data compression simultaneously with its programming function.

The station can be conveniently controlled and programmed by an on-site computer. For multi-site operation, programs can be sent to the different range sites by teletype and entered by a common paper tape to assure a common program at all stations.

In other respects, the Lockheed system is similar to current data-processing stations with some refinements added. It can accept raw, noisy PCM data of any format from a telemetry receiver, tape recorder or other source and completely regenerate the data, separating it into the individual channel and supplying it in parallel form to a computer with accompanying identification addresses.



HEART OF SYSTEM is this magnetic core memory. The high-capacity unit is small, also provides several computer functions.

It can also provide selected channels in analog form for visual display or recording. Accessory equipments are available for data compression, data limitation, on/off data displays, and other special tasks.

• **Highly flexible**—An unlimited number of variable word lengths is provided. Any number of different length words may be used in a frame or sub-frame of the PCM format. Four completely independent sub-frames with separate sync words may be employed in each main frame. In addition, any number of slaved sub-frames may be used. Main frames may contain up to 512 channels and sub-frames up to 512 channels each.

Any word may be up to 64 bits long. This includes both data and sync words. Sync words may be broken into up to five different pieces and distributed throughout the frame or sub-frame or word.

All sync control (frame, sub-frame and word) is designed for three modes of operation: search, check, and lock, with independent controls of these modes for frame, word and four sub-frames.

Self-test techniques in the station permit rapid fault location.

The PSY/101 PCM signal conditioner is used in the system. This unit exhibits state-of-the-art performance characteristics in both high- and low-noise environments. In addition, the unit has a frequency range up to two megacycles and handles seven code formats, with provision for more.

• **D-A converters**—DAA/101 digital-to-analog converters are included in the station to convert selected digital data channels to analog functions for driving display devices or analog recorders.

Each D-A has an individual thumbwheel-controlled selector for selecting the data channel to be converted. This arrangement permits completely flexible selection of channels without resorting to patch panels. Fifteen D-A modules are supplied in one seven-inch drawer panel.

An extremely versatile PCM signal simulator can also be supplied with the system. This unit provides five different, completely selectable words of up to 64 bits each, which can be arranged in a wide variety of PCM formats.

Formats with main frames and sub-frames up to 800 channels in length can be set up, utilizing the five selectable words. In addition, super-communication of either data words or the entire sub-frame may be simulated by a unique repeat feature.

To provide a special signal for use in maintenance, the simulator has the capability of manual-bid advance or word advance by means of front panel push-button switches. This feature allows the operator to advance an entire format into the data-processing system a bit (or a word) at a time.

• **Compact package**—The entire system, including the simulator, is supplied in a two-bay cabinet. The signal simulator, signal conditioner, D-A converters, paper-tape reader, and power supplies are mounted in one bay, while the digital processing circuitry and the memory system are mounted in unique "gates" in the second bay.

Gate-type construction of mounting facilities means any card can be easily withdrawn, or pin voltage measurements can be made on the connectors without removing the card. ■

Circle No. 225 on Subscriber Service Card

Solid-State Strain Elements

The General Electric Company is marketing a series of semiconductor strain sensor elements 60 times more sensitive than conventional wire strain gages.

Both single element and multi-element strain sensors are offered. The single element types are available in either the standard versions or in epitaxial versions. The multi-element strain sensors are all of the epitaxial type. Some of the sensor elements detect normal stress independent of shear stress while other sensor elements are designed to detect shear stress independent of normal stress.

In addition to the single element types, sensor elements now available include dual element gages, epitaxial square bridges, a universal skew bridge, a sheet shear sensor, a bridge shear sensor and a torsion bar shear sensor. The use of an epitaxial layer on a high resistance silicon material allows the strain sensor to be soldered or alloyed directly to the stress member.

Circle No. 226 on Subscriber Service Card

Crystal Calibrator

Digital Electronics, Inc., is marketing Crystal Calibrator, Model 1527, with outputs at 1 mc, 100 kc and 10 kc. The compact secondary timing standard comes complete with internal regulated power supply. The unit is adjusted to WWV and the drift rate is only that of the quartz crystal, which is better than 1 ppm/°C. This all solid-state unit does not require the long warm-up period associated with vacuum tube instruments. It provides variable amplitude positive or negative square wave output of up to 10 volts at an output impedance of under 300 ohms for driving low impedance transistor circuits directly. Rise time of 100 nanoseconds provides harmonic outputs for higher calibrating frequencies.

Circle No. 227 on Subscriber Service Card

Frequency Synthesizers

A fully-transistorized series of frequency synthesizers from Montronics, Inc., offers a 100-kc, 1-mc, or 10-mc range in the frequency spectrum up to 100 mc.

The synthesizer series features an output level of 1 volt rms into a 50-ohm load, non-harmonically related spurious content typically 70 db below the desired frequency, millisecond switching time and digital frequency control from front panel or remote location.

Accepting a 1 mc standard frequency input (optionally built-in, with long-term stability of 1 × 10^{-9} per day), any model will retain long-term stability and accuracy of the reference standard.

Typical applications include use in high-speed automatic test systems, data analysis systems, VLF frequency standard systems, and in communications receivers and exciters where the synthesizer provides conversion frequencies.

Circle No. 228 on Subscriber Service Card

Spectrum Analyzer

Gulton Industries has available a spectrum analyzer which contains 31 filtered outputs provided in both parallel and serial form in the analyzer, maintaining constant simultaneous surveillance of all frequencies of interest. The unit accepts sine wave, periodic complex and random signals and allows for real-time data reduction.

Fully automatic, the system saves hours of data reduction time in ground support or laboratory studies of vibration, sound, stress and fatigue.

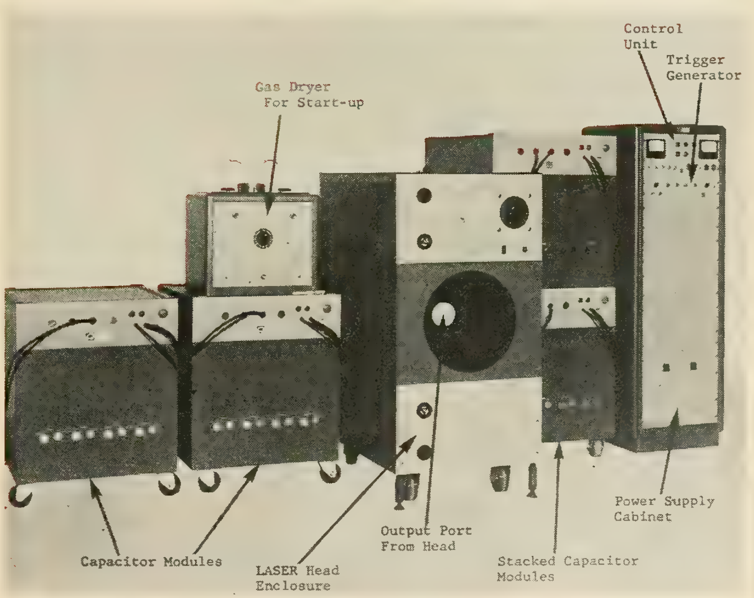
Circle No. 229 on Subscriber Service Card

High Voltage Chopper

The Solid State Electronics Corp. is marketing the model 150 High Voltage High Temperature electronic chopper. This is a solidly encapsulated plug-in unit designed to alternately connect and disconnect a load from a signal source. It may also be used as a synchronous demodulator to convert an ac signal to dc. It is capable of linearly switching or chopping voltages over a wide dynamic range which nominally extends down to a millivolt and up to ±150 volts. The unit can handle up to 5 milliamperes.

The Model 150 has been designed with a built-in transformer-coupled isolating network so that it can, for example, be driven from a 400-cycle power line or from a drive source that is common to the dc voltage being chopped. Sinusoidal or square wave drive may be used.

Circle No. 230 on Subscriber Service Card



New Product of the Week: 100-500 Joule Laser System

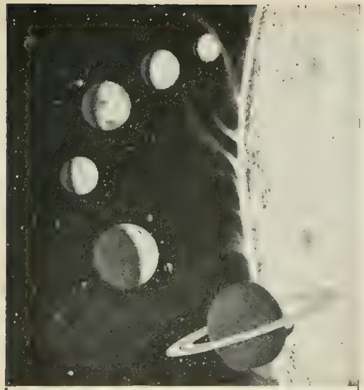
A superpower laser system with outputs of up to 500 joules has been developed by Radiation at Stanford.

The Model 3220 laser consists of a confocal-elliptic-cylinder optical pumping cavity, a charging supply, an energy-storage bank, a trigger generator and an interlock and control system.

The system features a 12-in. ruby rod pumped by 8 xenon flash lamps in separate, elliptical cavities. Rod ends and the aluminum cavity are cooled by liquid nitrogen.

The system's optical pumping cavity contains 8 confocal, elliptic cylinders, each of which contains a 5,000-joule flash lamp. Selection of a laser rod with a right-angle prism ground into one end results in a relaxation oscillator yielding a pulse duration of 500-1,000 microseconds and a beam divergence of ½ degree or less. Either a rotating mirror or Kerr-cell unit may be added to produce single-pulse power outputs in the multi-megawatt range.

Circle No. 231 on Subscriber Service Card



PROPULSION SYSTEMS ENGINEERS

North American Aviation's Space and Information Systems Division is staffing its fast-growing Propulsion Systems Department. Professional engineers and scientists of exceptional capability are needed to solve propulsion problems for America's most challenging manned spacecraft program.

ROCKET DEVELOPMENT

Duties will consist of planning and directing experimental development of liquid rocket engines or solid propellant rocket motors. Requires thorough knowledge of rocket engineering, skill in use of experimental techniques and proficiency in interpreting test data.

PROPULSION SYSTEMS DESIGN

Experience in one of these areas is required: Rocket engine installation design; propellant and pressurization system design; design of high performance flight-weight components such as valves, regulators and controls. Positions require competence in high-stress design, reliability and value engineering principles, thorough knowledge of materials and their compatability with propellants.

Other available positions include test, systems development, and project engineers. Direct your inquiries in complete confidence to **Mr. B. F. Munford, Engineering and Scientific Employment, Department 020, 12214 Lakewood Blvd., Downey, California.**

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

SPACE AND INFORMATION SYSTEMS DIVISION

North American Aviation

Diplexer/Detector Assembly

American Electronic Laboratories, Inc., has available the Model FDM-102 Subminiature diplexer/detector assembly that provides radio frequency isolation between a low-power UHF transmitter and an L-band crystal video receiver using a common antenna.

The unit is a three-port device providing a common antenna port to a low-power transmitter signal, a filter for the receiver signal and an integral video detector. The insertion loss of the assembly between the transmitter and antenna is 1 db; the input and output impedance of 50 ohms, and the crystal video detector has a tangential sensitivity of —50 dbm.

Circle No. 232 on Subscriber Service Card

Capacitor

Available from The Potter Company, a Model EA-4 capacitor is 0.125-in. dia., 0.250-in. long, and is rated 56,000 pf (0.056 Mfd), 100v dcw. Units are encapsulated in machined epoxy cases and are designed to operate over a temperature range of —55° to 125°C at full working voltage (100v dc).

The capacitance values of the 2042 series range from 10 pf to 56,000 pf, with standard capacity tolerance of ±10%. The total capacitance drift over the temperature range is less than ±15%.

Circle No. 233 on Subscriber Service Card

Magnetic Core Memory

Developed by DI/AN Controls, Inc., a magnetically controlled core memory, Model SA-VB-INT 240/12-400, has a read-write cycle time of 2.5 microseconds and an access time of approximately 0.8 microseconds. The shelf model has 240 words of 12 bits each and two address counters permitting use as a serial "variable block" buffer storage. The unit gives high reliability due to simplified magnetic address, drive, and sense circuitry, thus cutting semi-conductor count to a minimum.

Circle No. 234 on Subscriber Service Card

Band Reject Filter

A high-Q Band Reject Filter for signal elimination at specific frequencies in the 100-500-mc band is available from Dorne and Margolin, Inc.

Designed to withstand severe environmental conditions, the small, lightweight Model DM F6 band reject filter eliminates specific frequencies in the 100-500-mc band without detrimental effects on system performance at other frequencies. The unit is particularly well suited for multiplex use and for the elimination of radio frequency interference.

Rejection characteristics are provided by single cavity models with minimum insertion loss of less than 0.85 db below 0.98 fr and above 1.02 fr. Three cavity models increase the maximum rejection to greater than 50 db at fr ±0.1%, with less increase in band-pass insertion loss than normally found in multi-cavity band pass filters.

Circle No. 235 on Subscriber Service Card

Dual Power Supply

Trygon Electronics is marketing a series of dual supplies consisting of 21 different combinations of 6 basic individual supplies. The dual units are housed in a double decker configuration designed specifically for laboratory bench applications. Since the individual units in the dual supply are completely self-contained, they may be converted into single supplies by simply interchanging single dust covers for the dual cover.

All units may be operated in either the constant voltage or constant current modes with current limiting in the voltage mode and voltage limiting in the current mode. Coarse and fine adjustments are provided for the voltage and current controls.

The Dual Series of supplies feature voltage regulation of better than 0.05% and voltage ripple of less than 0.5 mv. Current regulation is better than 0.5 with current ripple less than 0.25%. Voltage stability is better than 0.95% with a temperature coefficient of 0.02%/°C. The supplies are remotely programmable and remote sensing is provided to maintain regulation at the load.

Circle No. 236 on Subscriber Service Card

Traveling Wave Tube

Microwave Associates, Inc., is marketing a high-power, broadband traveling wave tube (TWT) for UHF microwave applications.

The MA-2001C is an electromagnetically focused, forced air cooled traveling wave tube designed for E.C.M. applications and for new phased-array radars. High power and gain performance are obtained over an octave bandwidth.

The frequency range of the MA-2001C is 400 to 1000 mc, with a nominal power output of 300 watts cw. Nominal efficiency is 25%.

Circle No. 237 on Subscriber Service Card

Differential Equation Solver

Scientific Data Systems, Inc., is marketing a differential equation solver, the DES-1, which combines in a single machine features of both digital and analog computers.

A combination special purpose/general purpose digital computer, the DES-1 is specifically designed for use by people trained in analog programming techniques. It provides the flexibility, accuracy and input/output capability of digital machines while retaining the convenient, easy-to-program method of solving differential equations normally associated with analog machines.

Additionally, the DES-1 will allow problems to be changed in minutes without the tuning usually required in analog computers. Magnetic tape storage of problems and previous results permits the construction of a library that can be employed to minimize total programming effort.

The basic DES-1 includes a central processor with 8,192 words of overlapped memory, paper tape reader and punch, input/output typewriter, DES console, real-time clock, and graph plotter.

Circle No. 238 on Subscriber Service Card

Thin-Film Flip-Flop

The Model 11010FF, available from Halex, Inc., utilizes vacuum deposited resistors, capacitors, interconnections and terminals on a 8-in. square encapsulated substrate. Active components consist of micro-sized silicon diodes and transistors. Thickness of the module is 0.12-in. Flat ribbon leads can be welded or soldered. Maximum operating frequency is 2 megacycles with a supply voltage requirement of 5 volts ±10%. Power requirement is 7 milliwatts nominal. Input required to trigger the flip-flop is a 1.5 volt pulse. The module will operate over a temperature range of −55 to 85°C.

Circle No. 239 on Subscriber Service Card

Photo courtesy General Dynamics/Astronautics

Spir-O-line

aluminum-sheathed coaxial cables

and matching Spir-O-lok connectors

Prodelin's Spir-O-line coaxial cable systems are helping to supply information on spacecraft performance as an integral part of complex communications equipment.

On the Atlas-Centaur, for example — a high-energy space vehicle destined to explore the solar system — Spir-O-line is connected to the tracking antenna of the Atlas booster, and is also used in the Centaur telemetry-beacon-tracking systems. And in the Grand Bahamas, as part of the Azusa Mark 1 Tracking Facility, Spir-O-line helps track Mercury manned-capsule orbital flights.

We would be pleased to tell you more about these Prodelin products. Write for Catalog 591.

SPIR-O-LINE U.S. PAT. 2998472
SPIR-O-LOK U.S. PAT. 3010747

"THE WORLDS FINEST"
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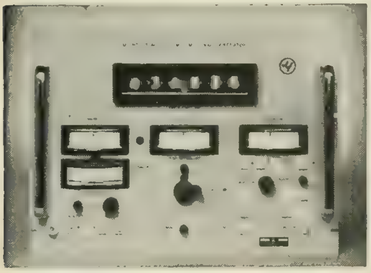
Pacific Div.: 901 American St., San Carlos, Calif. • 593-8277 • Area Code 415

Circle No. 4 on Subscriber Service Card

FM Signal Generator



Providing frequencies accurate to 0.0003%, Microdot's Model 412 operates in the 400-550 mc range with direct digital readout to 1 kc. Single-knob tuning permits continuous frequency coverage, fast setting and frequency search capability. Lighted push-button controls and 6-digit readout minimize human error and permit instantaneous output interpretation. Only 13 x 19 x 18 inches, unit is no larger than average of the five major components of less versatile generators. 95% solid-state.

Circle No. 5 on Subscriber Service Card

VHF-UHF
Power Oscillators

This complete line of precision units offers frequency ranges of 10 to 1050 mc with single-knob tuning. High power (50 watts), extremely constant output and highly accurate frequency control makes these units invaluable in research and development of rf equipment. Power supplies are regulated to 1%, conservatively rated components are carefully arranged for long life, easy inspection. Typical unit measures 8" x 11½" x 19"; weighs 45 lbs. Adaptable to rack mount.

MICRODOT INC.

220 Pasadena Avenue
South Pasadena, California
Overseas: MICRODOT AG, Zug, Switz.

Circle No. 6 on Subscriber Service Card

Miniature Rate Gyro

A microminiature rate gyroscope that eliminates need for conventional gimbals is available from Special Devices Laboratories, Inc.

The highly sensitive microminiature gyro, known as TeleRate, measures less than 1 cu. in. and weighs 1.5 oz. The low cost instrument, used as a sensing or controlling device, incorporates a new approach to gimballing by eliminating float arrangements, delicate bearings, torsion bars and critical pickoffs without loss of sensitivity. The angular momentum of the device is 62,500 gm-cm^2/sec.

TeleRate uses a synchronous motor to drive a hysteresis wheel and is capable of a wide range of full scale calibration. The unit consists of four basic assemblies; the base provides headers for electrical connection, registration for the output axis and mounting. Four coils in an inductive bridge arrangement make up the detector. The gimbal assembly provides the single axis freedom, damping and mounting for the spin motor. The motor assembly makes up the fourth section.

Circle No. 240 on Subscriber Service Card

Universal Test Unit

Uniflete (Universal Flexible Test Equipment), utilizing a basic design independent of the item being tested is available from the Mishawaka Division of the Bendix Corp. The basic system consists of a universal programmer, a digital evaluator and a signal processing unit. The addition of building blocks such as input power supplies, input signal sources, signal conditioners and a load and adapter unit represents a complete Uniflete for a particular application. The system is housed in two cabinets. One contains the basic Uniflete equipment while the other houses a digital recorder and the power supplies and signal sources associated with the particular application.

Circle No. 241 on Subscriber Service Card

Compact Power Connector

A line of completely environmental, light-weight power connectors is available from the Deutsch Co. electronic components division. These designs feature crimp-terminated, insertable-removable contacts. The socket contact features a new "Floating Plate" spring protection member that improves current to size ratios and extends durability of the contacts to more than 10,000 cycles of engagements.

These connectors meet or exceed all applicable specifications and are environmental without potting. Elastomers are molded oil resistant silicone. The connector withstands temperatures to 400°F., and retains dielectric separation to 100,000 ft. Contacts are rated from 25 amps for size 16 and up for larger contacts. A specially developed Locksmith keying system provides polarization in 210 alternate combinations, allowing a large amount of receptacles to be mounted in close proximity without danger of mismating.

Circle No. 242 on Subscriber Service Card

High Impedance Amplifier

Halex 365HI solid-state amplifier available from Halex, Inc., features high impedance and small package size. Circuitry consists of unity gain preamplifier, followed by a gain stage. Transducer matching is not necessary, amplifier follows sensor outputs with negligible loading effects. Input impedance is to 1000 megohms; output impedance is less than 30 ohms. Output voltage is 5 volts. Gain is 1 to 50 with 1% linearity. Frequency response is 2-20,000 cps. Unit operates over −65 to 165°F temperature range.

Circle No. 243 on Subscriber Service Card

Sealed Silver Batteries

Electrochimica Corp. is marketing a series of sealed silver oxide-cadmium cells for electronic, instrumentation and satellite applications. In comparable ratings, these cells offer approximately twice the capacity per unit weight and volume as the nickel-cadmium cells. The SCR-4 is designed for long-cycle life under conditions of altitude, temperature shock and acceleration found in aerospace applications. These cells are also well suited for electronic portable instrumentation applications where weight and volume are critical.

Circle No. 244 on Subscriber Service Card

Silicon Rectifiers

A line of silicon rectifiers for synchronous motor field excitation has been developed by Allis-Chalmers. Reliability is assured regardless of the number of hours of operation because voltage drop remains unchanged with non-aging silicon diodes.

The static exciters are available in ratings of 3-17 kw at 125 or 250v dc output (convection cooled), 21-50 kw at 125v dc output (fan cooled), 21-33 kw (convection cooled), and 40-50 kw (fan cooled) at 250v dc output.

Circle No. 245 on Subscriber Service Card

Analog Memory System

An analog memory and logic system is available from Electronic Associates, Inc. This system, known as the 231R-V Analog Computer System, is designed for high-speed iterative calculations and is the only analog computer capable of hybrid simulation. It includes such features as solid-state mode switching, multiple-speed repetitive operation, multiple time-scale selection as well as a separate mode logic pre-patch panel which permits extremely sophisticated programming.

Circle No. 246 on Subscriber Service Card

Trimmer Capacitor

A miniature ceramic trimmer capacitor designed for maximum component density in point-to-point wiring applications is being marketed by Erie Resistor Corp.

Adjustment of the rotor disc provides an approximately linear capacitance change per degree of rotation.

A conservative rating of 200 VDCW from —55° to 125°C insures inherent reliability of the Style 539 trimmer. The heart of the trimmer is the optically smooth bearing surface between the rotor and stator.

Circle No. 247 on Subscriber Service Card

Electronic Artist

An electronic artist capable of drawing straight or curved lines automatically into graphs, charts or maps in any combination of four colors, and annotating them with words or symbols, is available from Benson-Lehner Corp.

Electroplotter II, which translates numerical data into graphic form for visual interpretation, can receive its design and color instructions from magnetic tape, punched cards or tape, or directly from a computer. When instructed by magnetic tape, it can draw as much as five times faster than was previously possible with a mechanical device.

Circle No. 248 on Subscriber Service Card

Xenon Power Supplies

Christie Electric Corp. is marketing a line of xenon arc lamp power supplies, suited for such applications as solar simulators, data display systems, flight simulators and star tracking systems.

These versatile units may be used equally well with xenon or mercury xenon lamps and feature automatic current regulation and extremely low current ripple. Each unit is designed to work with two or more lamp sizes.

Circle No. 249 on Subscriber Service Card

DATA HANDLING ENGINEERS

To maximize success of future lunar and space probe flights, in-flight performance data must be conveyed rapidly, accurately, and reliably from vehicle to Flight Control at Cape Canaveral. Planning, systems design, and implementing the required instrumentation systems at range stations and the Cape is the task of Data Handling Engineers with Pan Am's Guided Missiles Range Division.

Prime areas of responsibility are complete systems for data processing and real-time computing, digital data transmission, range safety display, target acquisition, and analog/digital conversion. Engineering study is presently under way on:

- methods of data compaction
- data handling equipment, for radars and telemetry, spanning from Cape Canaveral to the Indian Ocean providing a high-capacity data transmission system with over 3000 bits/sec. and error rate less than 10^{-6} over a 3 kc rf channel
- display systems driven by multiple digital sources for range and missile operations control

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Audio Oscillator

Voltage-controlled audio oscillators offering stability both in frequency and amplitude during sweep, are available from Gulton Industries, Inc.

Premium performance is assured by the frequency and amplitude stability and ultra-low distortion. No harmonic component is greater than —45 db. All electronic circuitry, with complete absence of electromechanical components, ensures trouble-free operation and long life.

Problems usually encountered in precision oscillators—highly critical circuitry and temperature sensitivity—are eliminated by a unique servo loop design.

Circle No. 250 on Subscriber Service Card

Backward Wave Oscillator

Varian Associates is marketing a family of backward wave oscillators for radar, local oscillator, signal generator, panoramic receiver and close-range FM altimeter applications.

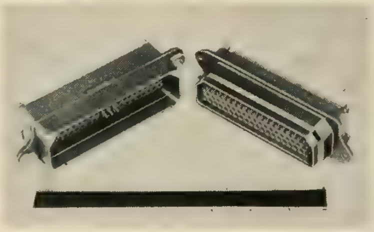
Covering frequency ranges from 1.0 to 40.0 gc, the "G" group of BWO's are all rugged, voltage-tunable and permanent-magnet focused. Minimum power outputs range from 5 to 50 mw and can be held at a uniform value throughout the band by use of the negative control grid.

A feature of the "G" tubes is electrical and mechanical compatibility, a feature important to the user who wants to use tubes having different frequency ranges in the same piece of equipment or to use similar power supplies and mechanical designs in a family of equipment. Spurious output is low, more than 60 db below the carrier level measured 1 mc or more from the carrier frequency. Noise in a 2-mc band measured at 30 mc is at least 90 db below carrier.

Circle No. 251 on Subscriber Service Card

Rack/Panel Plug

The DPJMB98 plug, a modified version of the Cannon DPJM is available from Cannon Electric Co. The unit is a miniature environmental plug incorporating the firm's Little Caesar Rear Release System. The system retains crimp, snap-in contacts by metal clips inside the monobloc-type insulator.



The contacts are removed with a simple plastic tool which is slipped over the wire and into the rear of the insulator. When fully inserted, the tool releases tangs on the clips and enables the contact to be easily withdrawn.

The 98 contacts are made of copper alloy and are plated with gold over silver. The insulator is diallyl phthalate, and the shell is made of die-cast aluminum with cadmium plating. The plug is keystone-shaped for polarization, and accommodates wire sizes #20, #22, and #24.

Circle No. 252 on Subscriber Service Card

Inverter Transformer

A miniature inverter transformer perfected for use in dc-to-dc or dc-to-ac transistorized power supplies in transistor and semiconductor applications and for printed circuit applications (solderable terminals) has been developed by Ferrodyne Corp.

The epoxy molded toroidal transformer is constructed to MIL-T-27A (Class S, Grade 5) specifications. The unit is designed for highest efficiency in operating frequency range of 60-5,000 cycles.

The output is from milliwatts to 1,000 watts with output voltage up to 2,500 volts and input range covers 24-32 volts.

Circle No. 253 on Subscriber Service Card

S-Band Parametric Amplifier

A low-noise S-band solid-state parametric amplifier has been developed by Micromega Corp. for application as a preamplifier in radar, telemetering and satellite-tracking receivers. Basic specifications: gain, 20 db; bandwidth, 50 mc; noise figure, 2.0 db max., including a 10-db second stage; frequency tuning range, 2900-3100 mc.

Circle No. 254 on Subscriber Service Card

—names in the news—

Holley B. Dickinson: Elected president and board member of Canoga Electronics Corp., Van Nuys, Calif.

Thor A. Bergstralh: Appointed head of the newly established Weapons Effects Dept. of the San Bernardino, Calif., operation of Aerospace Corp. **Robert N. Buland** named manager, flight control, electronic systems, of MMRBM program. **Solomon H. Turkel** appointed assistant manager, weapons systems analysis of the *MMRBM* program. **Max R. Grundvig** appointed section head, information processing section, Computation and Mathematics Center, Technical Div.

Charles M. Downs: Appointed advertising and sales promotion manager for Raytheon Co.'s Semiconductor Div., Mountain View, Calif.

Paul M. Kuhns: Joined the product support organization of Sylvania Electric Products, Inc., West Roxbury, Mass., as assistant manager.

Warren L. Vodak: Appointed sales manager of the Industrial and Marine Div. of Walter Kidde & Co., Inc., Belleville, N.J.

J. L. Brooks: Named manager of research and engineering for sensor products at General Dynamics/Electronics, San Diego, Calif.

Bert S. Cross: Elected president of the 3M Company, St. Paul, Minn.

Ronald D. Cone: Appointed director of engineering at California Computer Products, Inc., Anaheim, Calif.

John B. Dastrup: Appointed chief engineer of the Industrial Div. of Cubic Corp., San Diego, Calif.

Joel J. Dorman: Appointed manager of market research of Thompson Ramo Wooldridge, Inc., Hawthorne, Calif.

Joseph S. Bartos: Named director of the Avco Corp.'s Defense and Industrial Products Group Missile Management Center, Stratford, Conn.

Howard A. Bond: Appointed director of engineering-military electronics for Philco Corp.'s Communications and Electronics Div., Blue Bell, Pa.

Lester Eagle: Appointed quality control manager of Computer Instruments Corp., Hempstead, L. I., N.Y.

Dr. Horace R. Moore: Appointed associate manager of the Fluid Physics Div. of Electro-Optical Systems, Inc., Pasadena, Calif.

Bernard W. Hansen: Appointed personnel manager of Swedlow, Inc., Los Angeles.

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VEHICLE SYSTEMS Applicants should be familiar with systems design layout and systems integration including integration of structures, propulsion, GSE, guidance and control equipment of stages and stage interface designs.

WELDING, EXPERIMENTAL MANUFACTURING TECHNIQUES Will use engineering methods, concepts, theories and techniques to effect transition of welding research to specific applications on development of space vehicle components; develop new and modify existing alignment and assembly methods, processes and techniques; formulate solutions to special manufacturing problems to determine machinery and tooling requirements for space vehicle fabrication.

QUALITY ASSURANCE To participate in planning and implementation of MSFC's Quality Assurance Program. Specific duties cover a wide range of engineering activities to evaluate contractors' quality programs, parts qualification, testing of components and systems, procurement review, calibrations, failure analysis, process control, etc.

FLIGHT MECHANICS Theoretical research studies for space vehicles in one or more of these areas: optimization of space orbits, sensitivity of orbits to celestial influence, development of analytical formulation of space flight orbits, atmospheric reentry flights, stability and control of rigid bodies, guidance control systems and flutter and vibration.

GUIDANCE AND CONTROL SYSTEMS Control system component integration. Accelerometer, rate gyro and other control sensor performance testing and evaluation. Coordination of programming efforts for the Saturn automatic checkout system. Design, development, test and evaluation of flight control systems and/or associated components—electrical, mechanical, hydraulic or pneumatic. Senior and intermediate level openings.

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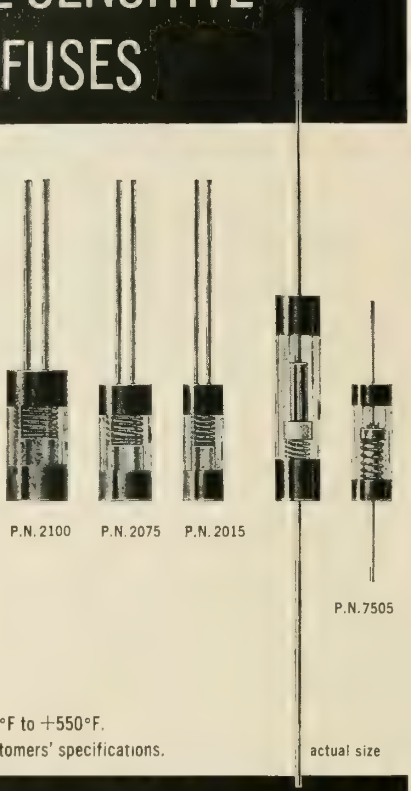

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ELECTRICAL:						
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Max. Applied Voltage to Fuse	600 V_{RMS} — 60 cps				600 V_{RMS} — 60 cps	
Insulation Resistance	1000 megohms min./500 VDC				1000 megohms min./500 VDC	
Contact Resistance	0.3 ohms max.				.005 ohms max.	
Resistance (after Firing)	50 megohms min.				50 megohms min.	
ENVIRONMENTAL:						
Ambient Temperature	—100°F to operating temp.				—100°F to operating temp.	
Shock for 2-4 msec.	100 G's				50 G's	
Vibration	20 to 1000 cps at 20 G's				20 to 500 cps at 15 G's	
DIMENSIONAL:						
Body O.D. (inches max.)	.250	.250	.325	.375	.285	.250
Body Length (inches max.)	.72	.72	.72	.80	1.25	.70
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Robert M. Clary: Appointed chief components engineer at Dresser Vacuum, Needham Heights, Mass.

James C. Martin: Named program manager for the vehicle engineering contractor department of Fruehauf's Military Products Div.-East, Detroit.

Roscoe Boone: Appointed director of manufacturing administration for the Boeing Co., Seattle.

Herbert F. McQueen: Named manager of manufacturing for Thiokol Chemical Corp.'s Wasatch Div. plants, Brigham City, Utah. **John E. Wallen,** manager of Air Force Plant 78, reassigned to the new space booster plant in Brunswick, Ga.

Thomas Sprague: Appointed corporate director of public relations for Aerojet-General Corp., El Monte, Calif.

Donald H. Bennett: Appointed public relations manager for Ryan Aeronautical Co., San Diego, Calif.

Hugh Brady: Appointed director of the *Apollo* program at the Milwaukee, Wis., plants of AC Spark Plug Div. of General Motors Corp.

Dr. C. Paul Boner: University of Texas physics professor and administrator, elected president of the Acoustical Society of America.

David R. Steenhausen: Named applications manager for the Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif.

Robert J. Moore: Promoted to assistant counsel at the IBM Federal Systems Div. headquarters, Rockville, Md.

Milton L. Deever: Appointed program director of the Motorola Military Electronics Div. Systems Research Laboratory, Riverside, Calif.

George S. Freeman: Elected executive vice president of Fenwal Electronics, Inc., Framingham, Mass.

George M. Arisman, Jr.: Elected administrative vice president of Sanders Associates, Inc., Nashua, N.H.

Zachary K. Geanes: Appointed director of marketing for the Librascope Div. of General Precision, Inc.'s Information Systems Group, Glendale, Calif.

John S. Derby: Elected vice president-industrial relations for Republic Aviation Corp., Farmingdale, N.Y.

Donald C. Dahl: Promoted to assistant to the treasurer at Page Communication Engineers, Inc., Washington, D.C.

Charles L. Prosser: Appointed market manager, Standard Steel Div. of Baldwin-Lima-Hamilton Corp., Burnham, Pa.

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—when and where

JUNE

Symposium on Materials and Processes for Space Power and Primary Propulsion, Society of Aerospace Material and Process Engineers, Bellevue-Stratford Hotel, Philadelphia, June 3-5.

COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland, June 3-11.

National Electronics Packaging and Production Conference, New York Coliseum, New York City, June 4-6.

Symposium on the Exploration of Mars, sponsored by the American Astronautical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections and NASA, Denver Hilton Hotel, Denver, June 6-7.

25th French International Air Show, Le Bourget, Paris, France, June 7-16.

American Society for Quality Control Reliability Training Conference, The Bishop's Lodge, Santa Fe, N.M., June 10-14.

AIAA Heat Transfer and Fluid Mechanics Institute, California Institute of Technology, Pasadena, Calif., June 12-14.

Symposium on Plasma Space Science, supported by NASA and Goddard Flight Center, Catholic University of America, Washington, D.C., June 12-14.

American Society for Testing Materials Annual Meeting, Purdue University, Lafayette, Ind., June 13-18.

Instrument Society of America National Biomedical Sciences Instrumentation Symposium, Sheraton-West Hotel, Los Angeles, June 14-17.

AIAA Summer Meeting, Ambassador Hotel, Los Angeles, June 17-20.

Institute of Electrical and Electronics Engineers, Summer General Meeting, Toronto, Canada, June 17-21.

American Nuclear Society Annual Meeting, Gatlinburg, Tenn., June 20-24.

American Institute of Electrical Engineers Summer General Meeting, Fontainebleau Hotel, Miami Beach, Fla., June 20-25.

Institute of Space Communications, sponsored by the University of Maryland with the cooperation of the Goddard Space Flight Center, University of Maryland, College Park, Md., June 23-28.

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Circle No. 66 on Subscriber Service Card

That MA-10 Flight

WHAT HAS HAPPENED to the eloquent Mr. James Webb, administrator of the National Aeronautics and Space Administration?

With some Congressmen, the astronauts and top officials of the Manned Spacecraft Center all pressing for another *Mercury* shot, one would expect Mr. Webb to be heartily in favor of it.

The NASA chief executive always has shown a politician's astuteness for the prestige and public relations value of the space agency's programs—indeed, so much so that some in the agency have tagged him as a bureaucrat rather than an engineering-oriented administrator.

Yet it is Mr. Webb, with some sound engineering reasoning, who stands firmly in the path of the *MA-10* mission. We think he is right.

Mr. Webb points out that the flight envelope of the *Mercury* spacecraft has been explored thoroughly, that unless an unexpected gap is found in the *MA-9* data all of the program's objectives have been met.

It is understandable that top program officials and the *Mercury* astronauts favor another mission. There is no question that in a science as young as space flight, much could be learned from an additional flight.

Those favoring the flight point out that some 18 months are expected to elapse between the Cooper flight and the first manned flight of the *Gemini* program. It even has been suggested than an additional *Mercury* shot might replace one or more of the *Gemini* missions.

But the fact remains that the beginning of the *Gemini* program is not 18 months away. The first unmanned launch is scheduled for late this year. The program involves an entirely new spacecraft and a booster which is untried as a man-rated vehicle.

There are problems with *Titan II* which must be solved before it can be used to launch the *Gemini* astronauts. New procedures must be worked out for the control networks. An intensive familiarization program must be conducted on both the booster and the vehicle. Problems of long-duration missions must be studied.

All of this requires the attention of the most experienced team at NASA—and that team is the *Mercury* team. To divert its attention to an *MA-10* mission might seriously affect the initiation of the *Gemini* program.

The *Mercury* spacecraft, brilliantly though it has performed, is an obsolete spacecraft, by both U.S. and Soviet standards. The faster the *Gemini* program can be pushed, the faster the U.S. will possess a spacecraft capable of many and extended missions in space.

In addition to its value in the civilian program, the *Gemini* spacecraft will contribute in no small measure to the nation's military space program.

The Air Force disclosed, at the Aviation/Space Writers Association meeting in Dallas late last month, that it will make a decision on procuring its own *Gemini* capsules after study of the early NASA launches. This means that the earlier the *Gemini* program gets under way, the sooner we will see an active manned military space program.

This is too important to be delayed by an additional *Mercury* mission which is not absolutely essential. To date, none of those proposing the *MA-10* mission has put forward a compelling engineering reason for the flight.

It might provide additional experience for the astronauts, making available an orbital flight for one of those who has made only a suborbital trip. As understandable as this urge is, however, it probably is more sentimental than practical.

An *MA-10* mission might indeed serve to fill that long gap between *MA-9* and the first manned *Gemini* mission—a gap in which the Soviets may be chalking up several spectacular achievements in manned space flight. But, as associate MSC director Walt Williams himself has pointed out, an additional *Mercury* shot might end in disaster rather than success—thereby destroying the prestige already built up by the program.

Nor do we believe the manned spaceflight team will go stale, since it will be actively engaged in preparations for the *Gemini* launches.

No, the only basis on which an *MA-10* shot can be justified must be a sound engineering and technical reason. It must also be of such overwhelming priority that it justifies the risk of delaying the *Gemini* program.

Quite apparently, there were technical problems on Maj. Gordon Cooper's 22-orbit mission. Some have been tracked down, others are under study. But these almost entirely are linked to the *Mercury* spacecraft. If the craft is not to fly again, the problems are of no significance.

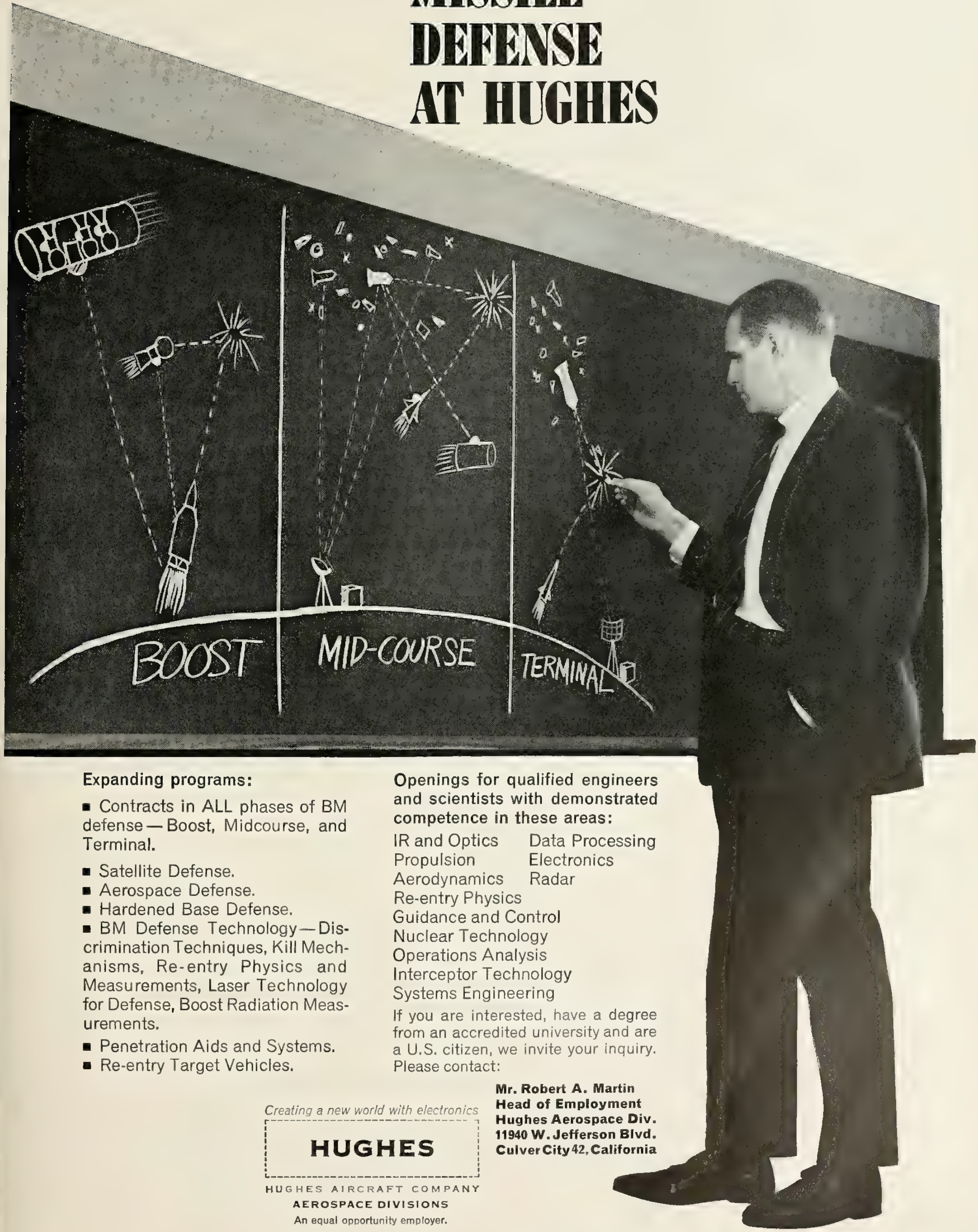
IT SEEMS UNLIKELY at this late date in the *Mercury* program that any problems will be found which are linked with the inherent difficulties of spaceflight itself—that is, problems which should be explored with an additional *Mercury* flight before *Gemini* progresses further.

Certainly, at this point in time, any such discovery will have little effect on design of the *Gemini* capsule. Dept. of Defense already has discovered, as Pentagon official Dr. Lawernce L. Kavanau pointed out in Dallas, that *Gemini* design has progressed to the point where there can be no significant DOD input.

Unless some significant gap is found in the *Mercury* data, Mr. Webb is absolutely right in standing up against the pressure for an *MA-10* flight.

William J. Coughlin

BALLISTIC MISSILE DEFENSE AT HUGHES



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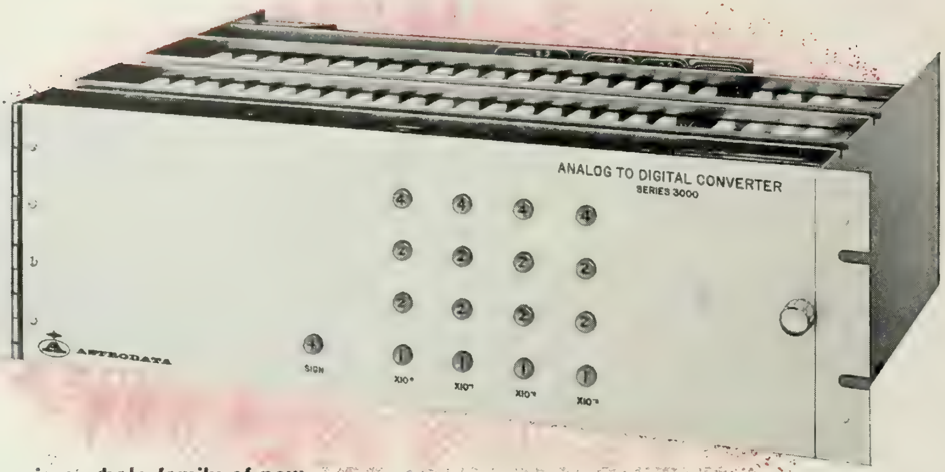

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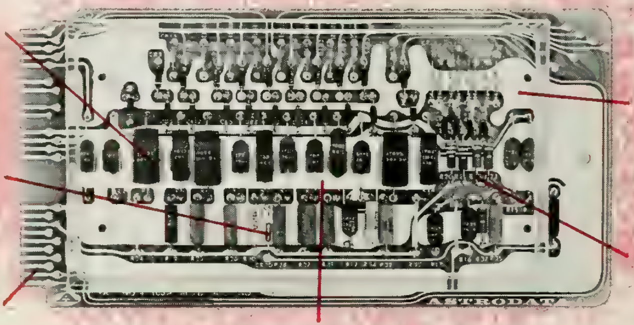

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Nike-Zeus Intercepts Titan-Boosted Vehicle

Report from Warsaw COSPAR Meeting . .

Study Indicates Space Gap Increasing . .

34,000-mph Re-entry Simulator Planned . 2

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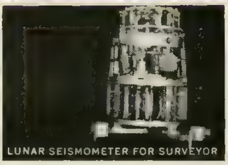

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missiles and rockets

Volume 12, Number 23 June 10, 1963

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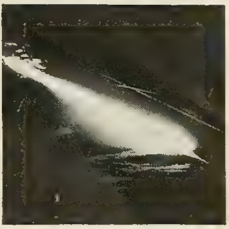

First photo ever released showing intercept of an ICBM-boosted target vehicle. In time exposure, target vehicle boosted by Titan shows as uppermost bright streak. Intersecting it is shorter streak made by Zeus. Bright spot at intersection is explosion of charge simulating warhead.

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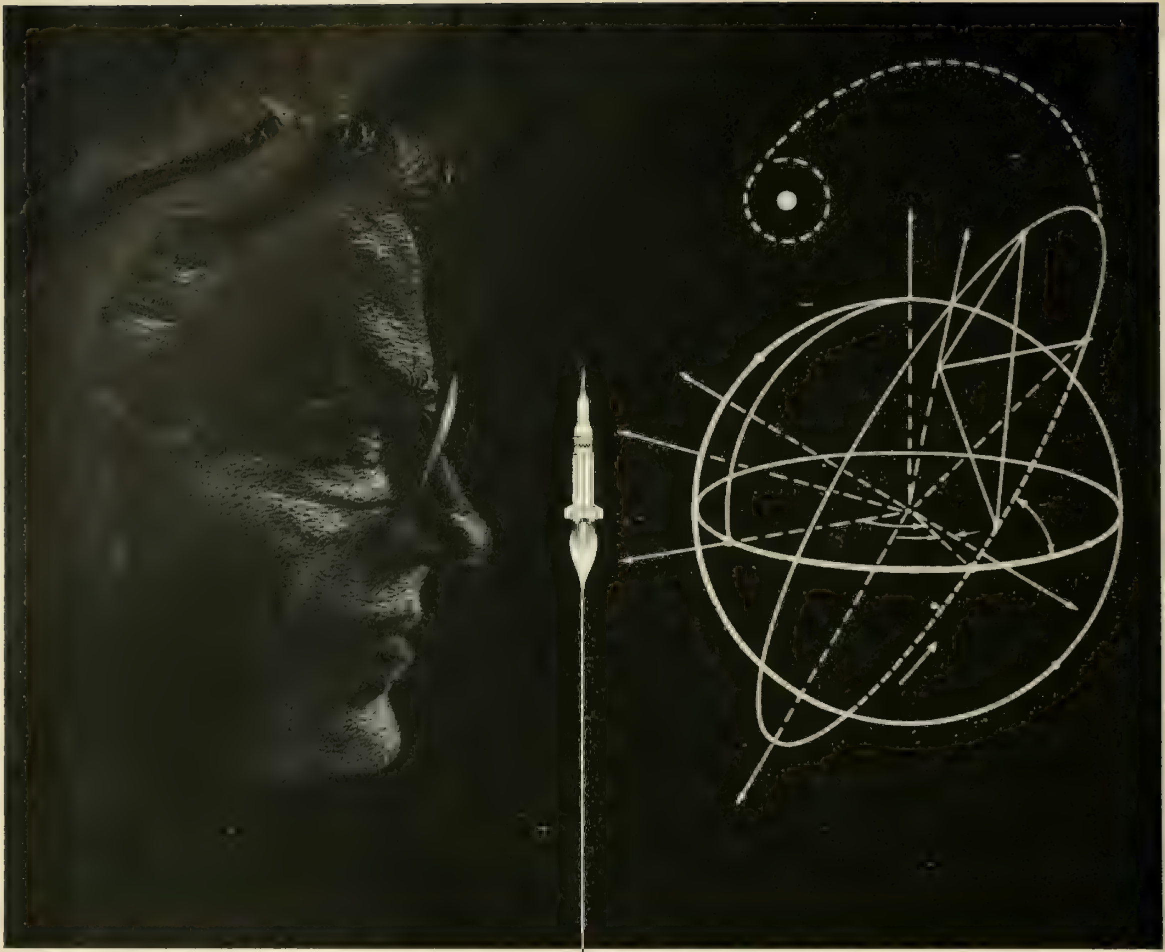

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Kudos from Concord

To the Editor:

I would like to express my compliments to you and your associates of MISSILES AND ROCKETS for the excellent editorial material found in your magazine.

Of particular interest to us is your Astrolog section, which is one of the finest quick-reference guides to our missile and space programs.

Rudolf F. Wagner
Systron-Donner Corp.
Concord, Calif.

Egypt's Rockets

To the Editor:

A reporter, in a feature story—datelined Cairo, April 16—presenting a German viewpoint in the Egyptian-Israeli missile controversy, claimed in the April 28 issue of the West German mass-circulation magazine *Stern*: "a solid-propellant rocket obtained (by Egypt. J. R.) from American manufacturer Cerva Levison, of Jewish faith, proved to be a dud, and for the not much better *Zinny* rockets American salesman Blair had asked unbelievable prices."

I wonder whether MISSILES AND ROCKETS—or any of its American readers—can identify Mr. Levison, Mr. Blair, the sounding rockets they sold to Egypt, and the firms that supplied those rockets.

In all fairness, I believe, both Mr. Levison and Mr. Blair—if they exist—should be asked to comment. This letter might be instrumental in achieving that aim. I therefore request you to publish it in your forthcoming issue.

J. A. Redeker
Science Editor
Algemeen Dagblad
Witte de Withstraat 73
Rotterdam, The Netherlands

MA-9 Coverage

To the Editor:

May I congratulate you on your excellent approach to the Gordon Cooper flight. It was refreshing to read in your article something besides the bare facts of what happened. I was very interested in your ideas on what this flight means to the *Mercury* program as a whole. I was also glad to see the smiling face of the Astronaut on the cover.

Lynn Stewart
New York, N.Y.

SpaceCom Institute

To the Editor:

The 1963 Space Communications Institute is being held at the University of Maryland June 23-28 in cooperation with the National Aeronautics and Space Administration.

We are asking your assistance in helping to publicize the Institute as a means of making your subscribers aware of an educational opportunity which might be of some interest to them. If it is within the framework of your policy to assist us in this matter, we would be most appreciative.

Inquiries as to details of the program can be obtained from my office.

Clive C. Veri
Institute Coordinator
Office of the Dean
University of Maryland
College Park, Md.

The 1963 Institute, sponsored by the University of Maryland in cooperation with NASA's Goddard Space Flight Center, has been "designed to accelerate the transmission of scientific knowledge and assist in reducing the technological gap in the state of the art." Several subject areas will be presented to encompass the theory and technology of all operations where radio transmission is involved in space science and engineering.—Ed.

Raytheon's ABRACADABRA

To the Editor:

During the last month we have received many hundreds of letters requesting copies of ABRACADABRA, our glossary of Space-Age abbreviations. The great majority of these requests were inspired by an inconspicuous editorial note on the Letters page of your April 22 issue, as we know either from direct reference or other evidence.

We wish we could show you the names; they read like a bluebook of government agencies and the defense industry. We are impressed not only by the caliber of your readers but also by their close attention to your pages.

You have every reason to be proud of your distinguished readership and your reader response.

Nathaniel H. Sperber
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Reprints of MISSILES AND ROCKETS' *latest Astrolog, the status report on missiles and space programs appearing in the May 6 issue, may be ordered from:*

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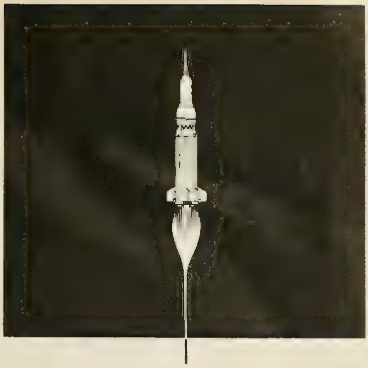

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The Countdown

WASHINGTON

NASA Studies Possibility of New Satellite

No decision has been made but NASA is studying possible development of a new satellite to fulfill its part of the new space cooperation agreement with the Soviet Union (see p. 18). The pact calls for each nation to launch a spacecraft for study of the Earth's magnetic field in 1965. The space agency may decide to include the experiment on one of the heavy observatory spacecraft scheduled for launch in that period. If a new satellite is developed, it will employ a *Delta* booster.

AF Studies Gemini-Titan III Combination

Air Force is conducting a series of studies on mating of the *Gemini* capsule with *Titan III* to overcome limitations imposed by the *Titan II* booster for launches with high orbital inclinations. A firm possibility is development of a drastically modified and expanded *Gemini* capsule to take advantage of *Titan III* weight-lifting capability.

Apollo Abort Tests Set for Mid-Summer

First off-the-pad abort tests with an *Apollo* boilerplate capsule will be made by NASA in late July or August. The tests with the *Little Joe II* booster will be made at White Sands, N.M.

SAMOS Ocean Recoveries Are Improving

Data capsules from Air Force *SAMOS* reconnaissance satellites now are being retrieved from the Pacific on a regular basis with pinpoint accuracy. As a result of these successes, AF will continue with ocean recovery and will not initiate any program for land recovery at new Aerospace Recovery Sites.

NASA Will Sterilize Planetary Spacecraft

NASA soon will announce that it will continue to fully sterilize its unmanned planetary spacecraft. The move is intended to reassure the scientific community, which has been concerned with NASA's dropping of terminal sterilization of the Moon-bound *Ranger*.

Altered Launch Angle Cuts Gemini Payload

Altering of the *Gemini* launch angle northward from Cape Canaveral to gain a landing capability at Edwards AFB, Calif., is expected to result in a payload loss of 75 to 100 lbs. This means Air Force might have to sacrifice some of its long-duration missions.

Polaris Program To Hit Peak in FY 1964

Downward trend in expenditures on the U.S. *Polaris* program is expected to start in Fiscal 1965. The program will hit its peak in FY '64. By then, a total of $10.6 billion will have been expended for 41 fleet submarines and their *Polaris* missiles, including the advanced *A-3*. Rear Adm. I. J. Galantin, director of Navy's Special Projects Office, confirmed to Congress recently that there are no plans for a follow-on to the *A-3*.

Single Agency Considered for Air Defense

Dept. of Defense is considering establishment of a single air defense agency, similar to Defense Communications Agency, to oversee all antiaircraft and antimissile projects of all services. Several industry firms also are pushing for the move.

NASA To Tighten Radiation Limits

The space agency is about to tighten radiation dose limits for manned spaceflight. Until now, 200 rad has been considered the permissible limit. But biomedical opinion now tends to a much lower value, perhaps 150 rad. Protective drugs seem to be effective in preventing intestinal damage and white blood cell depletion by acute radiation, but they have no apparent effect on delayed results such as leukemia.

X-20 Acceleration Comparable to X-15

Maximum acceleration of an *X-20* spacecraft launching by a *Titan III* is expected to be comparable to present *X-15* acceleration. The three stages will have equal burn-times adding up to 445 sec. NASA officials, incidentally, are continuing to press for continuation of the *Dyna-Soar* program regardless of any DOD decision to cancel.

McNamara Says Shelters Are Must for AICBM

Defense Secretary McNamara has informed Congress that he will never recommend an anti-ICBM program unless a fallout shelter program accompanies it. He says a "huge amount" of fallout will be produced by U.S. antimissile missiles as well as incoming Soviet missiles.

Atlas-Centaur Launch Set for September

Next launch of the *Atlas-Centaur* system is targeted for the second week in September—with some slippage likely. The stages are due for shipment to the Cape in about two weeks. The *Atlas* will be the last in the series to travel by road. A Douglas C-133 cargo plane has been modified to carry future *Atlas* boosters.

INDUSTRY

RCA Delivers First AN/FPQ-6 to AF

First of the AN/FPQ-6 radars has been delivered to the Air Force at Cape Canaveral by Radio Corp. of America. Capable of tracking to 32,000 miles (and to the Moon with modification), the 29-ft. dish replaces the principle tracking radar on Atlantic Missile Range, the AN/FPS-16, a 12-ft. dish with a 5,000-mile maximum range. Air Force will take delivery of seven AN/FPQ-6's, mostly for AMR installations. NASA will receive two, one for Wallops Island and one to be installed in Australia.

Denver Research Industry Study Due Soon

Denver Research Institute's soon-to-be-released study of spinoff benefits of the space effort will be used by NASA to gain further support for the space program. The survey reports there already have been several hundred specific benefits to industry from military and civilian R&D in the space area.

INTERNATIONAL

Foreign Officials Show ComSat Interest

Communications officials in Canada, Britain, France, West Germany and Italy have shown a strong interest in participating in a global communications satellite system. That's the word from on-the-scene exploratory talks by ComSat Corp. chairman Leo Welch and president Joseph Charyk. Now back in Washington, they will initiate talks with other countries soon.

—— Circle No. 2 on Subscriber Service Card

The Missile/Space Week

AF Studies Advanced ICBM

An "advanced ICBM," capable of global deployment in a dormant condition, is under study by the Air Force. Advanced packaging techniques and greatly improved reentry systems probably will prove to be the required keys necessary to open the way for such a future system, according to Maj. Gen. Joseph Holzapple, USAF.

Further, implied the AF deputy chief of staff for systems and logistics, an advanced ICBM of this type must also possess a faster reaction and deliver a heavier payload than the improved *Minuteman* ICBM now in development.

Speaking recently before a local meeting of the American Institute of Aeronautics and Astronautics in Washington, D.C., the AF official stressed the danger of relying too heavily on current operational or near-operational weapon systems. Instead, the U.S. military must press its exploration of space and continue antimissile development.

More Astronauts To Be Named

NASA has announced that it will select 10 to 15 new astronauts later this year, but no scientists will be included in the group.

The space agency set a deadline of July 1 for civilian applicants and July 15 for Navy and Air Force pilot recommendations.

The group, it said, will join the current astronauts in October, bringing the total number to about 30.

A NASA official said that the current 16 astronauts and those to be selected later this year will serve as pilots for all agency manned spaceflights through several *Apollo* missions. He said that if further missions are added to the NASA program, it is likely that additional astronauts will be needed.

Two major changes have been made in the selection criteria: the age limit has dropped from 35 to 32 and certification as a test pilot is no longer mandatory.

To qualify under the new rules, a candidate must:

—Be a United States citizen born after June 30, 1929, and six feet or less in height.

—Have earned a degree in engineering or physical sciences.

—Have acquired 1,000 hours jet pilot time or have attained experimental flight test status through the armed forces, NASA or the aircraft industry.

—Be recommended by his present organization.

MA-10 Decision This Week

Dr. Hugh L. Dryden, deputy NASA Administrator, declares that a final decision on an additional manned space flight in the *Mercury* series will be made this week.

Dryden told MISSILES AND ROCKETS after a meeting of top NASA officials on *MA-10* that the mission would be considered for a few days with a final decision to be made some time this week.

Dryden's statement followed shortly after Walter Williams, deputy director of NASA's Manned Spacecraft center, proposed that an additional flight of a minimum 100 hours' duration be approved (M/R, April 1, p. 14).

Space Agency Administrator James E. Webb said that Williams presented a most persuasive argument.

He said that "on balance" he would prefer to move ahead on *Gemini*, despite the fact he was torn between a desire to do both *MA-10* and *Gemini.*

Atlas Explodes in Silo

An *Atlas F* missile exploded in the hole at Walker Air Force Base, Roswell, N.M., June 1. The explosion occurred during a routine training exercise by a SAC crew. During the countdown, they were to the point of off-loading the LOX when the explosion occurred. There were no casualties and no civilian property damage.

Short-Pulse Radar Promising

Short-pulse radar may offer the ability to discriminate between adjacent airborne or ground objects, providing a method for target identification not previously available.

In development for more than five years at General Dynamics/Electronics in San Diego, the system was demonstrated for the first time last week in Washington, D.C., at the company's exhibit at the 17th Annual Armed Forces Communications and Electronics Assn. convention.

A chief advantage of the short-pulse technique, said GD/E engineers, is its ability to eliminate "clutter" in the received echoes. Tests at low power have shown, for example, that people can be readily distinguished from trees and equipment at ranges well over 1,000 ft.

Orbital Lab Studies Let

NASA study contracts for a manned orbital research laboratory —each totaling about $400,000—have been won by Boeing Co. and Douglas Aircraft Co.

Each firm will study an orbital lab system outlined by NASA under the three-month contracts, plus one or more alternative systems.

The NASA concept calls for a four-man orbital workshop providing for changing crew members and for periodically resupplying the vehicle.

The system would make maximum use of the *Saturn* launch vehicle, the *Gemini* spacecraft for crew rotation, the *Atlas-Agena* for re-supply, and of range tracking and data systems now being constructed.

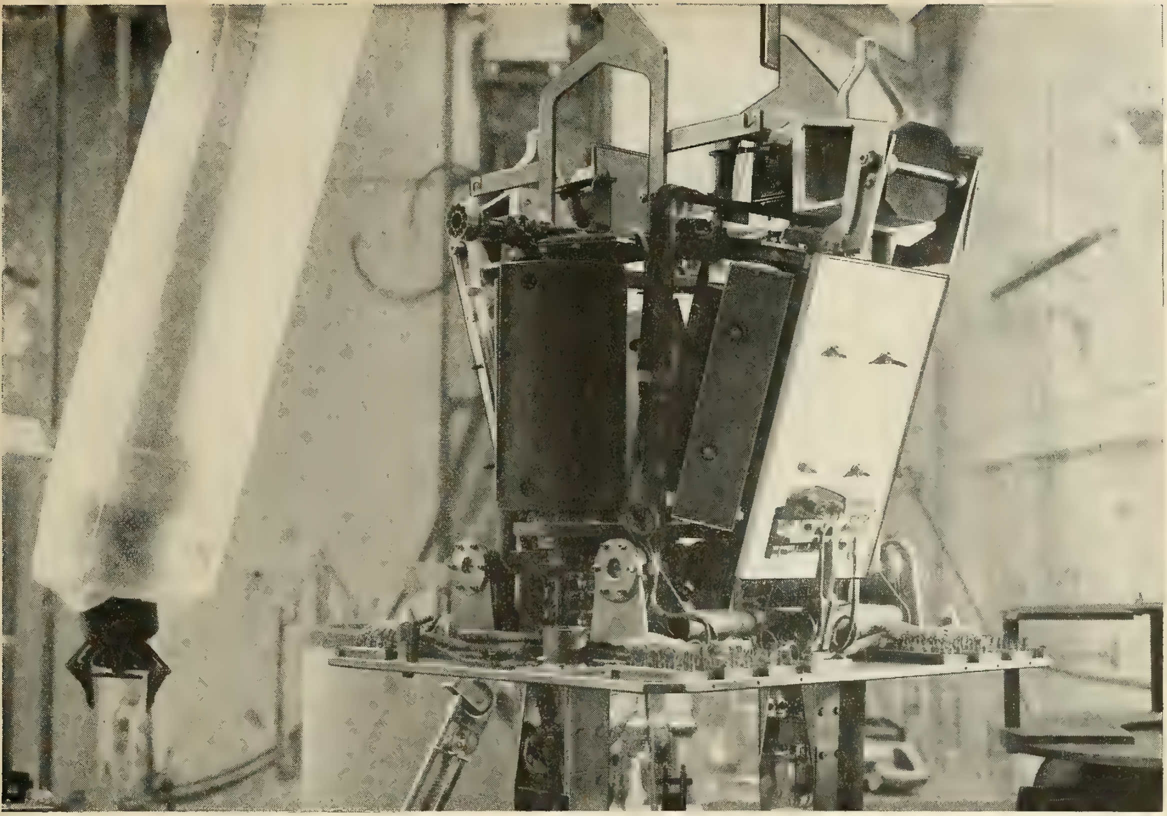
Goddard Offers Small Probe

NASA's Goddard Space Flight Center has offered to provide world scientists the design of a small rocket payload and a ground telemetry station that could be used in combination for ionospheric research.

The small payload, which weighs about 70 lbs., was detailed to the Warsaw COSPAR meeting in a paper presented by Dr. Siegfried J. Bauer and John E. Jackson of Goddard's Planetary Ionospheres Branch. They said its "versatility, simplicity and relatively low cost should make it an ideal tool for the investigation of the many problems of the ionosphere by the international scientific community, especially during the International Year of the Quiet Sun."

Shots of the Week

Random failure of a "50-cen item" has been blamed for a *Titan I* first-stage fire and explosion ove Cape Canaveral May 29. Secon stage of the 115-ft.-long ICBM wa destroyed by the range safety office after it separated and started to fal



How you can help develop compact nuclear systems for space

Now, at Atomics International, you can take part in one of the most advanced nuclear projects of our time: the development of SNAP compact power systems for space. A.I., as a SNAP systems prime contractor for the Atomic Energy Commission, is responsible for the complete nuclear power system including development and integration of the reactor and shield, power conversion and space radiator subsystems. Complete flight systems are subjected to both nuclear and non-nuclear launch qualification. SNAP systems are designed to provide from 500 to several thousand watts of auxiliary power while operating unattended in space for a year. SNAP is one of many challenging nuclear projects underway at A.I.

Atomics International offers excellent growth opportunities for men of talent and imagination. Requirements include BS or MS in engineering or physics and strong analytical or experimental abilities in heat transfer, fluid mechanics, thermodynamics, mass transfer, nuclear analysis or component development. Ability to plan, direct and evaluate programs for development of space reactor components and systems essential. You are invited to inquire for further information.

Contact: Mr. H.F. Newton, Personnel Office,
Atomics International, 8900 DeSoto Avenue,
Canoga Park, California

Atomics International technician begins disassembly and examination of SNAP 2 Development Reactor in hot cell following completion of reactor's 21-month test operation program. AI conducts SNAP 2 program for Atomic Energy Commission.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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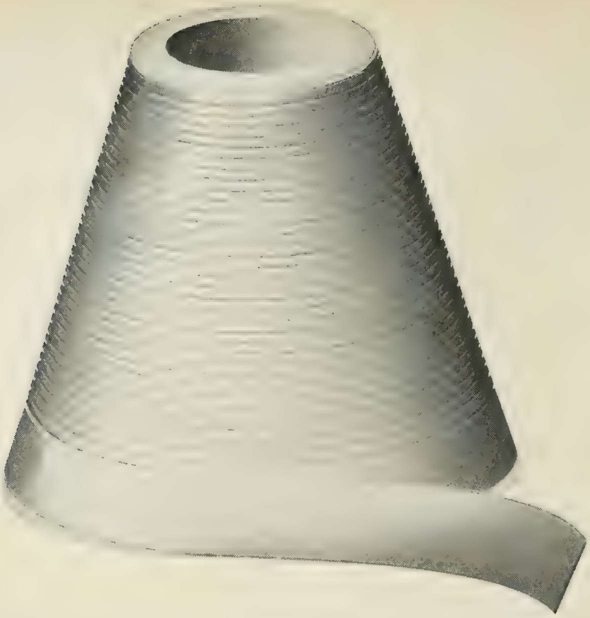
Division of North American Aviation



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Winds faster, drapes smoother
to speed production of top quality parts

You can produce more good parts per day with Tayloron 5031 tape. Its high tensile and high elongation reduce tape breakage, permit it to drape uniformly over various configurations, enable you to increase winding rates by as much as 50%. Wrinkles are reduced in cured parts too.

Tayloron 5031 tape also provides a weight saving up to 23%—its specific gravity is only 1.34 when cured at 1000 psi. It yields a lower thermal transfer than other asbestos phenolics, while maintaining their low char and erosion characteristics.

Tayloron 5031 tape is recommended for wound structures used in low and medium-velocity (to Mach 1.5) applications. This phenolic asbestos-nylon material is also supplied in broadgoods and chopped squares. Write today for complete technical data.

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Other Tayloron materials for rockets and missiles: combinations of asbestos, asbestos-nylon, graphite, high silica, nylon and glass reinforcements with modified phenolic resin. All are offered in tape, chopped squares, broadgoods, and molded forms.

It was the first failure of a *Titan II* first stage in 15 launches. Clouds of toxic nitrogen tetroxide left by the explosion drifted harmlessly out over the Atlantic and dissipated miles from land.

Other shots of the week:

- A *Minuteman* ICBM launched May 28 from Cape Canaveral successfully flew more than 4,000 miles down the Atlantic Missile Range. The silo launch was the last to be performed by Boeing Co. personnel before turning over future AMR firings to the 6555th Aerospace Test Wing, Patrick AFB, Fla., but Boeing employees will continue to conduct pre-countdown and post-launch activities on the missile.
- The *X-15* rocket plane reached maximum altitude of 92,000 ft. and a maximum speed of 3,750 mph during a successful flight from Edwards AFB, Calif., May 29 to investigate high-speed heating rates at low angle of attack. In a secondary flight task checking on control methods with the ship's automatic damping system off, NASA chief research pilot Joseph A. Walker, reported no problems.
- A Martin *Mace* tactical missile was successfully fired by an Air Force crew at Cape Canaveral June 5 in a training exercise.
- President Kennedy witnessed successful firings of six Army missiles June 5 at White Sands Missile Range: *Honest John, Little John, Sergeant, Hawk, Nike-Hercules* and *Nike-Zeus.* A double firing of the Navy's *Talos* failed to intercept the QF-80 drone.

Conflict of Interest Defined

A new Department of Defense directive has formally defined conflict of interest for government contractors. Stated intent of DOD directive 5500.10, dated June 1, is assurance of fair competition.

To avoid what Special Assistant to the Secretary of Defense Adam Yarmolinsky terms, "pseudo competition" (wherein a contractor furnishing technical management advice on a program may gain unfair competitive advantage over other contractors in the process), the directive restricts a company from bidding to furnish systems hardware for a program if it has provided technical direction or systems engineering without participating in other phases of development.

Another conflict the directive intends to circumvent is the possibility of such a consultant-contractor making a biased recommendation favoring hardware his firm might ultimately supply.

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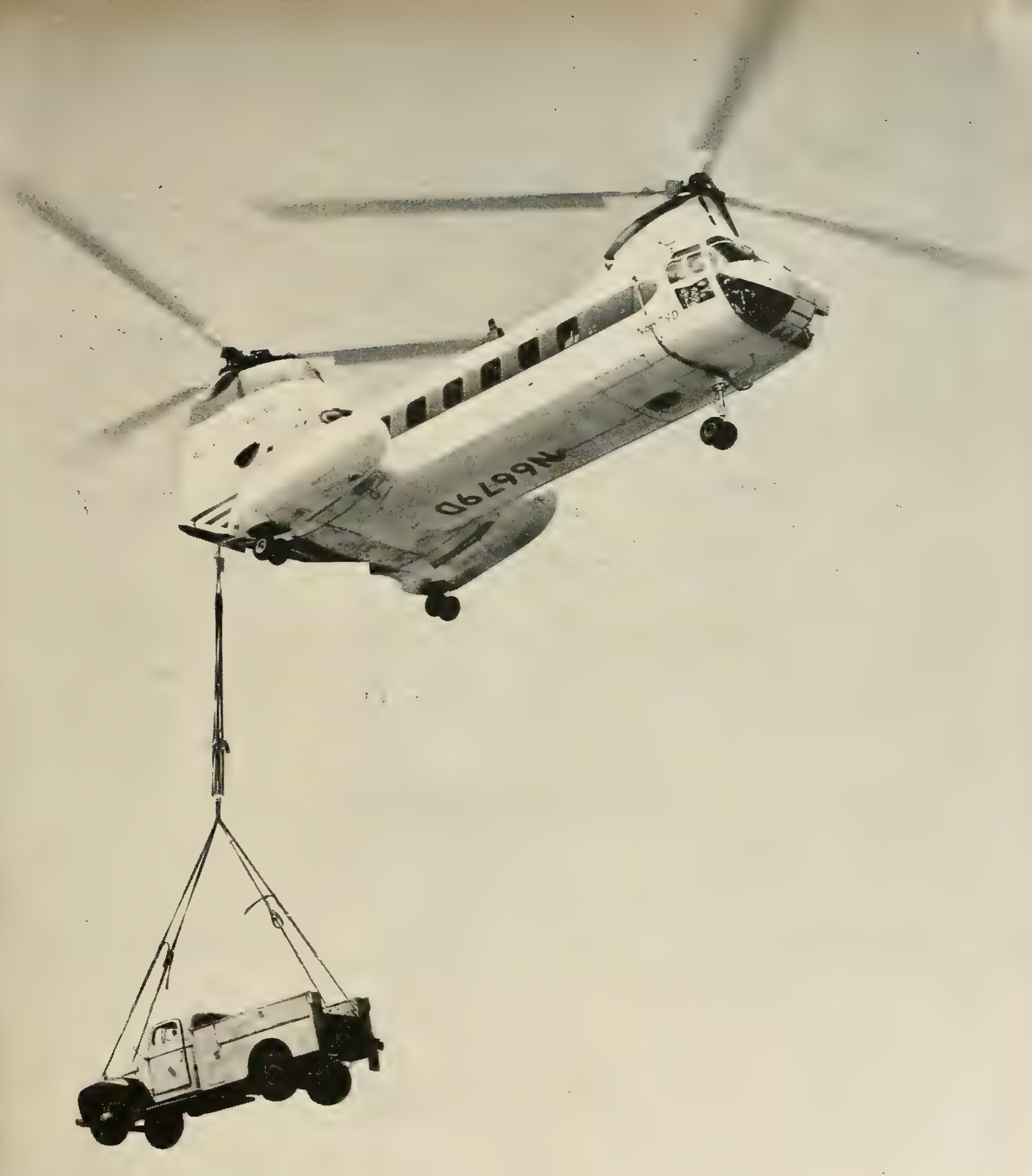

We've got 4,500 pounds by the tail

Picking up a load and swallowing it whole—without having to touch down—will be a unique feat for a helicopter.

This new technique of aerial rear-ramp loading will add important new capabilities to the already impressive versatility of the Boeing Vertol 107. The ability to lift a 4,500 pound truck in this manner is one of the many advantages of the tandem rotor configuration.

Helicopters have an impressive new range of operating flexibility when they're freed from landing-site loading. They can pick up heavy objects such as radar equipment, and pallets for personnel and supplies in any kind of terrain—jungle, marshy or mountainous. They can retrieve certain space hardware from the water. They can change pick-up or drop areas on call. And once having made a pick-up, they can put the normal payload inside the cabin where it belongs...and proceed at rated airspeed.

The Boeing Vertol 107 is another example of creative engineering, forward thinking weapons system program management and the vast resources of the Boeing Company.

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Circle No. 16 on Subscriber Service Card

Soviets tell COSPAR . . .

Cosmonauts To Fly This Year

USSR gives no details, but outlines plans for other shots; nations stress sounding rockets

by William Beller

WARSAW—The USSR plans to launch more cosmonauts this year and will also investigate "faraway regions of outer space and the planets of the solar system" during 1963, Russian academician A. A. Blagonravov told an international group of space scientists last week.

Additional *Cosmos* launchings and rocket soundings also are scheduled for the balance of the year, he said.

Blagonravov, head of the department of technical sciences at the USSR Academy of Sciences, discussed Soviet plans for unmanned launches in a surprisingly extensive report delivered to the Fourth International Space Science Symposium of the Committee on Space Research (COSPAR), convened here June 2-12. Nearly 20 other nations also read their reports.

His announcement of plans for manned flights this year—ending a 10-month gap in cosmonaut flights—was made at a press conference. He did not specify dates or any other details.

The U.S. report, presented by Richard Porter, an official of the General Electric Company, laid heavy emphasis on international cooperation in space. The fruits of such cooperation were displayed in the reports of a number of countries which credited NASA and the National Science Foundation for their help.

The Soviet Union, on the other hand, referred only to its cooperation with the United States.

Blagonravov disclosed some new technical details of the Mars probe and the flights of *Vostoks III* and *IV*.

Pointing out that communication with the Mars probe, launched Nov. 1, was conducted by both Earth command and automatic on-board equipment, he said that duration of these radio contacts was for 1.5 to two-hour periods. Ground-station transmitters at the Soviet's long-range space communications center had mean power of 100 kev.

"Prolonged and regular two-way radio communications with a space probe to distances of 106 million kilometers were accomplished for the first time in the world," Blagonravov claimed. It was done, he said, via "low directional and sharply directional onboard antenna."

- **6.5 free-float hours**—During the flight of *Vostok III*, launched Aug. 11, Cosmonaut A. G. Nikolayev on four different occasions unstrapped himself and floated freely for a total time of 3.5 hours. Similarly, Cosmonaut P. R. Popovich, pilot of *Vostok IV*, launched Aug. 12, made three such tests for a total free-float time of three hours. Results show no deleterious effects on the men and "they were able to work well in the weight-free environment," said the academician.

The Soviet scientist confirmed earlier data that the minimum distance between the two craft was about 6.5 kilometers and that respective launch times were within one second of calculated.

"In 1962 in the Soviet Union, artificial Earth satellites were tracked by 82 visual tracking stations and by 23 photographic tracking stations," Blagonravov said. The astronomical Council of the USSR Academy of Sciences was responsible for these activities. He reported that 58 space objects (29 Soviet and 29 American) were tracked. It is interesting that the Soviet by its own account did not track all of the 52 U.S. satellites successfully launched during 1962.

The number of visual observations made by the Soviet was impressive, however. According to Blagonravov's figures more than 50,000 such observations were made of Soviet and U.S. satellites during about 11,000 station traverses.

Total number of British optical observations in 1962 was about 8,600 on approximately 88 different orbiting objects—indicating less voluminous data on a greater number of satellites.

The Soviets claimed that "objects up to plus-nine stellar magnitude were observed" by optical means. "The accuracy of these observations was one tenth of a degree in position and one tenth-second in time."

Stated accuracies of the Soviet photographic observations were within four to six minutes in position and .005 seconds in time. With the cameras used at the 23 photographic stations, photographic tracking of satellites down to the fourth stellar magnitude was conducted.

- **Silent Chinese**—Some 240 space scientists registered for the COSPAR meetings, among them a delegation of 18 from the USSR and a group of five from Red China. The Chinese, however, gave no papers.

One Chinese delegate with a good command of English was asked whether his nation has a sounding rocket program. He answered that "We are doing physical research." He gave the same answer to subsequent queries on other matters.

The breach between Red China and the Soviet appeared in subtle form when Blagonravov pointedly read his speech in English—a highly exceptional and difficult task for the academician.

- **Stress on soundings**—COSPAR, organized five years ago by the International Council of Scientific Unions to continue cooperative work started during the International Geophysical Year, deals chiefly with scientific information derived from rocket and satellite research. For this and economic reasons, heavy emphasis during the meetings was laid on sounding rocket activities of various nations.

This sounding work will reach a

peak in 1964-1965, the International Years of the Quiet Sun. Many countries sketched their plans for such research for these years and described new vehicles being devised for the occasion.

The Soviet disclosed that it launched 71 sounding rockets during the past year. Blagonravov said 51 were fired from a high-altitude observatory in Franz Josefland, 19 from expedition ships in the Pacific Ocean, and one from a medium latitude in the Soviet.

Stated objective of Russian sounding rocket work was similar to that of other countries—to gather information on temperatures, densities and winds in the upper atmosphere with no overall theory to lock together the mass of such data given at the symposium.

One COSPAR delegate called it "a case of an immense amount of facts seeking a law."

- **British effort**—Britain is encouraging Commonwealth nations to go into space research. It is also working with India and Pakistan in an effort to get closer space cooperation, the COSPAR meeting was told.

In its own rocket work, the spokesman for Britain said, grenade explosions are being used increasingly as a means for extending wind and temperature structure measurements to greater heights. Observations are made on the gas clouds arising after a grenade is detonated in the higher atmosphere.

"In nighttime firing the clouds are self-luminous at heights between 100 and 150 kilometers," he said, while in twilight firings they may be observed for a useful interval of time up to 200 kilometers altitude by scattered sunlight."

In an attempt to accurately measure the atmospheric density between 100 and 200 kilometers altitude, University College, London, was reported preparing an experiment using a 6-ft. falling sphere to be tracked photoelectrically after ejection from *Skylark* rocket.

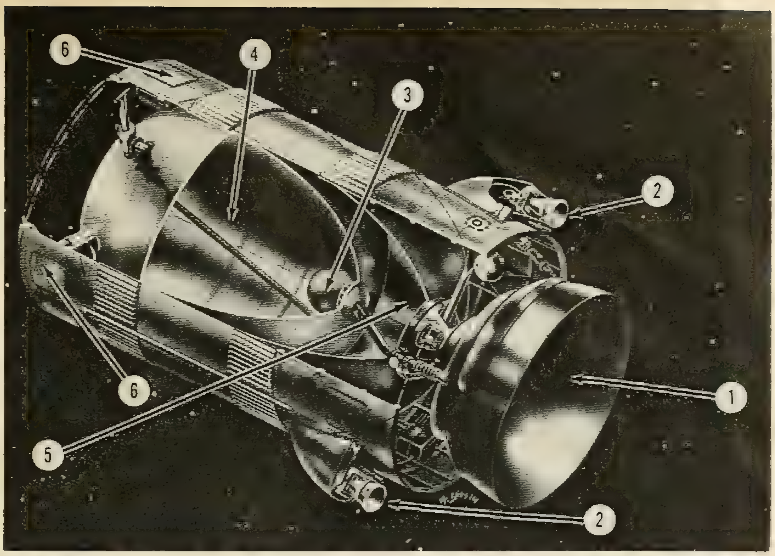
Britain also announced continuing development of its 5-in. meteorological rocket. Designed for regular use from small ranges, the rocket is to provide measurements of temperature and winds up to a height of 50 to 60 kilometers and "it is hoped that the first launchings will take place before the end of 1963."

- **Other nations**—Since the last COSPAR meeting, Argentina has started a rocket sounding program. It is the first Latin-American nation to do so. The program was accomplished "as a result of COSPAR's recommendations," the Argentine delegate said, "and with the cooperation and substantial assistance of the French Centre National d'Etudes Spatiales."

In its rocket facility established at Chemical (Province of La Rioja,) Argentina reports having a launcher for *Centaure* or *Bélier* types of rockets, a blockhouse with all necessary control and communications systems, radar and phototheodolite platforms, and assembly shops.

Both Canada and Japan are developing sounding rockets. The Canadian delegate described his country's *Black Brant 888* as a small, 10-in.-dia. rocket with a designed capacity for carrying 20 kilograms to over 150 kilometers. "This rocket has been proved by firings during 1962," he said, "and will be ready for use for scientific experiments before the end of 1963."

Japan is developing a *Lamda*-type sounding rocket able to carry a payload up to 1,000 kilometers. The Japanese delegate said a test of the rocket will be made this summer, and final testing is due next spring. ■



German, British Displays at Paris Show

FIRST PICTURES of two principal exhibits at the Paris Air Show which began June 6. At top is an artist's conception of a high-energy hydrogen-fluorine rocket proposed by West Germany for the third stage of the launcher being developed by the European Launcher Development Organization (ELDO). The manufacturer, Boelkow-Entwicklungen, says the stage is "completely optimized" and is pressure-fed, rather than pump-fed. Callouts on drawing indicate: 1) Main engine with E-D nozzle, 2) Vernier engines with gimballed frames, 3) Helium container, 4) Hydrogen tank, 5) Fluorine tank, and 6) Guidance and control equipment modules. Above is a new missile launcher carrying twelve Seacat antiaircraft missiles made by Short Brothers & Harland. System is designed for installation on fast patrol boats.

Rand report confirms . . .

Soviet Aerospace Program Well-planned, Closely Military Oriented

Air Force-sponsored study breaks USSR's space effort into four categories: Earth-orbiting, lunar, interplanetary and Cosmos phases; indicates Russia-U. S. technology gap widening despite fourth-stage difficulties

by Frank G. McGuire

THOUGH PLAGUED by fourth-stage difficulties that prevent interplanetary vehicles from leaving parking orbits, the Soviet Union's four-phase space program still threatens to leave the United States far behind in manned spaceflight.

These conclusions have been drawn by a Rand Corp. report which details the Soviet effort. The report describes it as a well-planned approach to space research that places most emphasis on Earth-orbital manned flight.

The Air Force-sponsored report, prepared by F. J. Krieger, assumes in its first sentence that the Soviet aerospace program is an integral part of the Soviet military program.

The four phases of the USSR effort are:

—Earth-orbiting man-in-space program, the objective of which is manned interplanetary travel.

—The lunar phase, characterized by launchings of *Lunik* vehicles, three of which have been made. This phase is a scientific subsidiary to phase one.

—Interplanetary phase, a logical extension of phase one, marked by the Venus probe of February, 1961, and the Mars probe of November, 1962.

—*Cosmos* Earth satellites, an adjunct of phase one, began appearing in March, 1962. The announced purpose of this series is investigation of the upper layers of the atmosphere and outer space, but Krieger declares "its real significance is most probably paramilitary."

• **Paramilitary satellites**—Krieger reports the *Cosmos* series of heavy satellites is to be the program of directly military oriented space development by the USSR. These payloads, on which little has been released, have appeared only since March 16, 1962, and have been launched from two Soviet Union sites.

The series was the first to break with the pattern of orbital inclination of 65°. Its inclination was 49° relative to the Equator.

The *Cosmos* series payloads launched from Tyuratam cosmodrome are presumed to be approximately equal to the *Vostok* series in mass and dimensions and are believed to have been recovered. Tyuratam cosmodrome is located east of the Aral Sea in Soviet Central Asia.

Smaller payloads in the same series are launched from the Kapustin Yar cosmodrome north of the Caspian Sea. These payloads, Krieger says, are placed in elongated orbits by more economical rockets than the Tyuratam series, and they are not recovered.

Payloads launched from Kapustin Yar have an orbital inclination of 49°, while the 65° inclinations mark payloads launched from Tyuratam.

(MISSILES AND ROCKETS made the first public disclosure of the Kapustin Yar cosmodrome's existence in February, 1958 (p. 61). The Tyuratam cosmodrome has presumably been built since then. Kapustin Yar has been in use as a missile test range for some time.)

Of the Tyuratam-launched satellites, Krieger states, *Cosmos 4* and *7* were ostensibly precursors of *Vostok III* and *IV* space vehicles, which carried Soviet Astronauts Nikolayev and Popovich around the Earth simultaneously on a "group flight."

Krieger points out that the four Soviet astronauts have acquired a total of 192 hours and 25 minutes' orbital experience, while their four American counterparts, including Cooper, have acquired 53 hours and 25 minutes.

"At the present rates of progress, this disparity will become even more acute," the Rand author says, also noting that "the *Vostok III* and *IV* spaceships permitted two men not only to survive four and three days, respectively, in space but also to exercise some control of the vehicle, perform calisthenics, carry out prescribed work routines, communicate with ground stations and with each other, and, finally, to land in a pre-determined area."

"It is evident that the Soviet man-in-space program is not only well planned and well handled, but also enjoys a high priority as well as a high degree of success."

• **Long-duration flights**—The rapid-fire string of heavy satellites now being placed in orbit on a regular basis by the USSR may well be forerunners of a new development in manned or multi-manned space vehicles of extended duration, he adds. The *Cosmos* series of satellites is apparently being used for equipment checkout and systems tests before manned launches, in addition to gathering data on radiation and other environmental parameters.

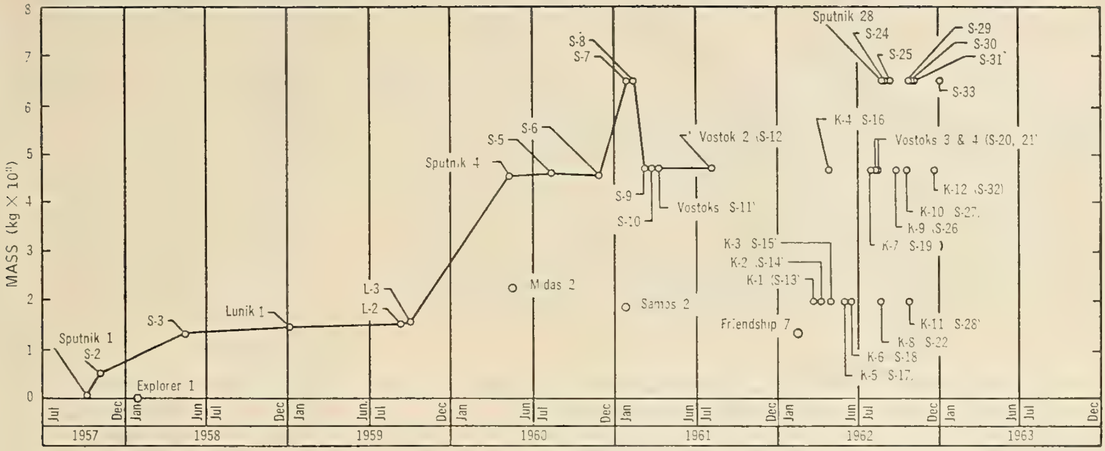


CHART SPELLS OUT Soviet booster superiority by illustrating the relative masses of payloads placed in orbit by Russia and the U. S. since the launching of Sputnik 1.

The announced purpose of the entire *Cosmos* series has been to conduct the following studies: concentration of charged particles in the ionosphere for investigation of radio propagation; corpuscular fluxes and low-energy particles; the energy composition of the Earth's radiation belts to evaluate dangers associated with prolonged space flights; primary composition of cosmic radiation and varying intensities thereof; the Earth's magnetic field; shortwave radiation of the Sun and other cosmic bodies; the upper layers of the atmosphere; effects of meteoric matter on design elements of space structures; and the distribution and formation of cloud systems in the Earth's atmosphere.

In addition to these experiments, elements of space vehicle construction will be worked out.

The mission of *Cosmos 11,* Krieger indicates, was not in line with the rest of the series and its assumed intent. *Cosmos 11,* launched October 20, preceded the Soviet high-altitude nuclear tests by just two days. It is assumed that a connection exists between this satellite and the USSR's nuclear weapons program. In the few days after its aunching, three nuclear detonations were set off at high altitude over Central Asia. Each was less than one megaton n yield.

• **Parking orbit trouble**—The only reason the U.S. has had a successful nterplanetary probe (to Venus) ahead of the Russians, Krieger indicates, is because two Soviet attempts ran into difficulties with communications and injection from their parking orbits.

These Venus probes were part of a string of interplanetary frustrations, nearly all of which were caused by inability to successfully transfer from a parking orbit to an interplanetary trajectory. The first Venus probe, launched from *Sputnik 8* in February 1961, was off-course by one million kilometers, due largely to an inaccurate injection into its interplanetary trajectory. The second one never left its parking orbit.

Another such attempt was the Mars I probe launched from *Sputnik 30* Nov. 1, 1962. This probe, weighing nearly a ton, is due to come silently within 120,000 miles of the planet about June 19. Telemetry has been an admitted failure.

In addition to the partially successful probes to Mars and Venus, the USSR has suffered a series of almost total frustrations in its interplanetary program. The first Venus probe was off course by a full order of magnitude and the Mars probe disappeared from contact weeks ago. At least six large Earth satellites intended as launch platforms for deep space probes failed to eject their payloads properly.

One of these occurred in August, two in September, and one each in October, November, 1962, and January, 1963. Presumably, the first three were attempted Venus probes, the next two were Mars probes, and the sixth a lunar probe because it was launched after the acceptable period for Mars and Venus probes. All the vehicles were unsuccessful in their missions, except that they did attain Earth orbit.

Had the August probe been successful, Krieger states, the payload would have arrived at its target of Venus on Dec. 7, 1962, one week before the successful U.S. *Mariner II* probe.

• **Lunar program**—This particular phase of the USSR space program has been silent lately. Since 1959, Krieger says, there has been a conspicuous absence of successful launches. Launching Jan. 4, 1963 of *Sputnik 33,* however, indicates something new is afoot in this phase.

Sputnik 33 had an early demise, apparently during an attempt to transfer from an Earth orbit to a lunar trajectory. The Rand report sees this launching as possibly the first in a series of attempts to start the long-awaited and highly publicized Soviet assault on the Moon.

"The Soviets are continuing to find that the road to interplanetary space is beset with difficulties. Their activity was almost frenetic between late August and early November, when, apparently having lost their magic touch, they suffered failures in three attempts to launch Venus probes and enjoyed only one partial success in three attempts to launch Mars probes.

"The lone successful Mars probe launching, however, did establish another astronautical precedent very essential to the Soviet ideological framework of technological achievements. The United States will not be able to match this particular feat until the opportunity presents itself again in 1965," the report concluded. ■

Action due this week . . .

NASA's Space Budget Goes Under House Knife

Total cuts could approach $500 million, with Manned Space Flight subcommittee taking $300-million slice

by Heather M. David

NASA'S SPACE BUDGET faces cut recommendations of well over $300 million this week by the House Science and Astronautics Committee.

Biggest slice will come from action taken by the Manned Space Flight subcommittee. The subcommittee is considering cuts of about $300 million—"a little more or a little less"—subcommittee Chairman Olin Teague (D-Tex.) told MISSILES AND ROCKETS. The action, however, must get full committee approval.

The Applications, Tracking and Data Acquisition subcomittee will reduce its portion of the budget "by roughly $80-90 million." Chairman Kenneth Hechler (D-W.Va.) said in an exclusive interview. "Cuts by the total committee will be on the order of $300-500 million," said House Space Committee Chairman George Miller (D-Calif.).

Miller added, however, that these cuts will probably take the form of "deferments," rather than cancellations of the programs affected.

Congressman Miller also announced his intention to get the subcommittee reports by June 15, and full committee action speedily afterwards.

All three subcommittees of the Science and Astronautics Committee (Space Committee) appear to be hitting specific programs rather than making percentage cuts.

Conservative resistance to the record budget appears to have run high in executive sessions, and only a Soviet space shot is likely to save the budget from the unexpectedly large trimming.

- **Manned spaceflight subcommittee**—Funds for the M-1 engine may be pared to a minimum from the requested $45 million in R&D money and $16 million in facilities. However, the committee is expected to leave just enough money in the program to keep it alive, in deference to members supporting the long-range programs.

Apollo will probably suffer a token cut, although liberals say the funds will be available if NASA needs them in supplemental appropriations next January. *Gemini* will also get close scrutiny, although cuts in the slipping program will probably amount only to postponing action on facilities no longer necessary this year.

The long-standing question of whether NASA's aerospace medical facilities duplicate those of the Air Force and other government agencies again has become a point of debate for the Manned Space Flight subcommittee. Some members of the committee still feel strongly that this duplication exists, and the $21-million budget is expected to get a partial, though not crippling, trimming.

- **Space Sciences subcommittee**—*Rover, Surveyor, Ranger* and *Mariner* are getting the most attention from this subcommittee, which is still in the middle of executive sessions. However *Mariner* is considered out of any danger in view of its success last year, which, Congressman Miller pointed out, impressed Congress greatly.

The *Rover* nuclear rocket program particularly is expected to fall under the Congressional fiscal knife. Committee members have voiced displeasure with the lack of progress in the program.

The *Centaur* booster seems to be in good shape with the committee this session. Joseph E. Karth (D-Minn.) Chairman of the Manned Spaceflight subcommittee, said "*Centaur* is just now getting the chance it has needed to be successful, and it should be given every opportunity to succeed." He said that the problems of poor management, low priority, and a poor testing program, which his subcommittee scored last year, have been cleared up.

In general, Karth said, the subcommittee will cut individual programs rather than make a percentage reduction.

- **Applications, tracking and data acquistion**—Hechler told M/R the general trend of his committee is toward a cut of 8 or 9% in a selective fashion. Some programs will receive specific cuts, and others a percentage reduction, with specifics left to NASA's discretion.

The subcommittee is strongly in favor of the meteorological satellite program, but is going over the others in considerable detail. ■

New U.S.-USSR Space Accord Expected

U.S.-USSR space cooperation has taken another major step forward with an agreement to launch satellites to study the Earth's magnetic field in 1965.

Dr. Hugh L. Dryden, deputy NASA Administrator and chief U.S. negotiator, told MISSILES AND ROCKETS the two nations have agreed to launch one satellite each and to exchange and compare data received from the flights.

The pact, Dryden said, "will be final as soon as it is approved by the Soviet Academy of Science." He said the Russians have waived the 60-day waiting period before such space cooperation agreements become effective and have indicated that this one will be ratified as soon as possible.

The new agreement amends the space cooperation pact which the two nations announced on March 25. The original agreement stated simply that the two nations would cooperate in charting the Earth's magnetic field. It also provided for cooperation in the weather and communication satellite areas.

Dryden said no further formal sessions or meetings are planned between himself and the chief Russian representative, Academician A. A. Blagonravov. Settlement of final details will be left up to lower-level representatives of both countries.

At this point, Dryden said, he foresees no major area of future cooperation. He indicated that the prospects for such an undertaking will depend upon the success of the current agreement.

He admitted that the U.S. has informally proposed cooperation in the area of unmanned planetary missions, and implied that the proposal probably was discussed by scientists of the two nations attending last week's COSPAR meeting in Warsaw.

RI report shows . . .

Aerospace Firms Chafe At Government Control

THE AEROSPACE INDUSTRY longer holds the initiative in pio- ering technical developments, and col- tively feels "discomfort" in the rela- nship it has with the government. ese conclusions, drawn from a re- rt by Stanford Research Institute, mmarize the main points presented on eas of friction between the industry d government.

SRI, which prepared the report for erospace Industries Assn., noted that nsiderable disenchantment exists "on sides" of the relationship, and spells t industry complaints against the gov- nment.

Five major problem areas were de- ribed in the report: "excessive con- ol" over industry by procurement encies; "burdening the procurement ocess with socio-economic objectives;" dustry's belief that the government's creasingly stringent attitude concern- g allowable costs is detrimental to the dustry; disagreement over the defini- on of fair profit; and the absence of "free market environment."

The government contends, says the RI report, that the industry must be osely watched because "without close pervision or risk-carrying incentives, dustry cannot always be depended on to fulfill its contractual obligations time or at reasonable costs." This ntention is backed up by government perience, the report says.

• **Stanford recommendation**—The RI report suggests to industry that it evote more of its potential to devel- ping newer and more efficient means reaching hardware goals, instead of ncentrating on defending itself. The vernment, on the other hand, should evelop simpler and more effective sur- illance techniques, SRI noted.

Lack of mutual confidence and re- ect between the two parties engenders uch of the trouble, the report says, rhaps because neither understands the her's role.

At the Pentagon, the initial reaction the report was agreement that the oints of friction and misunderstanding ould be eliminated. Industry spokes- en acknowledged the need for a better lationship.

The study finds that industry is often e party held responsible for the rights and wrongs of hardware, despite the admittedly close control by the government. Hence, industry must work to clarify the relationship or continue to lose effectiveness when it speaks in its own behalf.

• **Industry dilemma**—The nature of the relationship, based on contractual agreements, is such that industry finds that, on the one hand, it has no place to go with an appeal, but, on the other hand, is burdened with considerable responsibility expected from free enterprise "while serving the vital needs of the nation and selling to a customer with considerable bargaining power."

If industry is not content to accept its declining role in the relationship, the SRI report points out, then it must take the initiative to change things. Barring this, the study continues, it can anticipate an increasingly regulated environment. Failure of the industry in the past to deliver certain major systems within the time and cost allowances originally promised have, SRI points out, forced the government to set up the existing surveillance system.

Government regulation of the aerospace industry is accomplished, SRI says, not through an independent commission before which each side can present its case, but unilaterally through procurement regulations and other provisions in contracts. This transforms the industry to some extent into a closely controlled agent of the government for the operation of "arsenals," which is nevertheless still expected to act with the drive and efficiency of private enterprise.

The report also commented that certain organizations, serving ostensibly in a technical advisory capacity, have usurped portions of the role which the aerospace industry should fill, and the participation of these organizations in the R&D field is increasing.

AIA President Karl G. Harr said decisions on the SRI recommendations for future action will be made after the association has discussed the report with appropriate Defense Department officials. The association said it hopes the study, which cost $165,000, will pave the way for a joint-industry-government effort to improve the relationship. ■

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Technical Countdown

ELECTRONICS

Magnetic Test Facility Due At Goddard

A facility designed to accurately simulate the magnetic environment encountered by space vehicles will be developed and installed at NASA's Goddard Space Flight Center by Spectra-Physics, Inc. under a $585,000 contract. The magnetic test field is generated by three perpendicular sets of coils ranging up to 22.5 ft. in diameter. Special generating devices will permit fields up to 60,000 gammas, pointed in any fixed direction or rotating up to 10 rps about any axis. A geomagnetic observatory will be included to offset any variations by the Earth's field.

Laser Beam to Track Satellite

A ground-based laser beam will be reflected back to Earth from the *S-66* polar ionosphere beacon satellite soon to be launched by NASA. The laser, expected to be located at Wallops Island, will have a slant range of 1500 km and the reflection will be handled by 360 corner reflectors produced by Corning Glass from fused silica. Boxton-Beel, Inc. fabricated the reflectors under a contract from General Electric. The polyhedral reflectors will have a hexagonal pupil and will be ranged in nine arrays each carrying 40 reflectors bonded together.

High-Temp Semiconductor Crystals Grown

High-temperature transistors may be a possible application of Beta-phase (cubic) silicon carbide crystals now being successfully grown by researchers at Martin-Orlando. These very hard crystals can operate at 600-800°C, opening the door for a number of potential semiconductor devices in this region. Since the cubic crystals will accept infrared photons and emit optical radiation, another possible use is in an invisible-to-visible laser scanner.

New Dielectric Tape from RCA

A multilayer strip consisting of a transparent base, thin-film conductive, photoconductive and polystyrene dielectric layers in development at RCA's Astro-Electronics Div. may eliminate magnetic storage and film/flying-spot scanners from photographic satellites. The tape is capable of extended multiple readouts and is relatively insensitive to radiation. Readout can be accomplished at different speeds, thereby accommodating various power and bandwidth requirements in different applications. Potential resolution of the tape is such that RCA experts consider other parts of the system to be the limiting factors—the optics and electron beams.

ADVANCED MATERIALS

90,000°F Shock Tube At Avco

Avco-Everett scientists J. C. Camm and P. H. Rose are reaching temperatures as high as 90,000°F in a specially-designed electric shock tube using waves travelling up to 43,000 fps. in aerodynamic heat transfer studies. A newly developed heat-transfer gauge capable of measuring the radiated heat from the shock wave is being used. The temperature level lasts only two-millionths of a second. A second effort involves measuring the intensity of the radiation from the shock wave to reach the total radiative heat encountered by a space vehicle in planetary re-entry. The work is reported in the current issue of "Physics of Fluids" published by the American Institute of Physics, 335 E. 45th St., N.Y. 17.

Water Welder Upgraded

A self-contained unit producing a welding flame of 6000°F using only water and house current has been perfected by the Henes Mfg. Co. The welder will handle the entire range from 16-gauge sheet metal and ferrous 0.25-in. bar down to mil-sized electronic wires. The device produces, mixes and immediately conducts to the torch tip, the components of distilled water. The hydrogen-oxygen torch can also use a small booster that adds methyl alcohol vapor to the mixture to produce a highly reducing flame. Torch tips range from 0.003 to 0.048 in. orifice diameter.

PROPULSION

Ultra-fast Burning Solid Propellants Studied

Controllable ultra-fast burning rates for solid rocket propellants may be achieved with a new approach under development by Martin-Orlando materials research scientists. The technique reportedly involves no major change in the propellant system chemistry. Research is aimed at obtaining high mass flow without sacrifice of loading density for advanced missile-interceptor motors.

Thiokol, Aerojet to Study Sprint Propellant

Feasibility studies aimed at a new *Sprint* propellant are underway at both Aerojet-General and Thiokol Chemical Corp. under $350,000-contracts from the *Nike-Zeus* Project Office at Redstone Arsenal. Aerojet's work on the solid will be performed at Sacramento, Calif., while Thiokol will use its facilities at Huntsville. Ala.

Packaged Inflatable Space Structure Underway

The Viron Div., Geophysics Corp. of America, is building a compact, inflatable structure designed to be erected without the use of electrical equipment, yet small enough to be carried by one man. The fully-erected structure will be air-tight with inside dimensions of 7 ft. in diameter and 7 ft. high. The unit will be made of AlFor, a new type of honeycomb structure with an expansion ratio of 24 to 1. The material was originated by Sidney Allinkov and Fred Forbes of the Air Force Systems Command's Aeronautical Systems Division. The structure is being built under an ASD contract totalling $108,000.

SPACE MEDICINE

Gemini Trainer Environmentally Controlled

A one-man environmental control system will be developed for the *Gemini* trainer by Garrett-AiResearch. The system will use lox to supply ventilation, metabolic oxygen and suit pressurization for an 80-min. mission. A lithium-hydride cannister will remove CO_2. The $100,000 contract with McDonnell Aircraft calls for delivery of three complete systems.

Facility Will Simulate 34,000-mph Re-entries

Thiokol-built Ames hypervelocity complex to consist of three tunnels for testing planetary return velocities

by John F. Judge

POCATELLO, IDAHO—The first hypervelocity facility capable of simulating planetary return re-entry velocities—more than 34,000 mph—with aerodynamic models is being fabricated here by Thiokol Chemical Corp.

The test complex, consisting of three structures, is being built under a $1.3-million contract with the Ames Research Center, National Aeronautics and Space Administration. Completion is expected within a year.

Currently available facilities are limited to velocities of about 30,000 fps—adequate for the simulation of Earth-orbit re-entry, but planetary re-entry velocities approach 50,000 fps.

The Ames hypervelocity free-flight facility will combine the advantages of light gas guns with shock tubes. Aerodynamic models will be fired through a high-speed gas medium moving in the opposite direction.

The concept was developed in 1951 under the direction of H. Julian Allen, Ames' assistant director for aeronautics.

Flights of scale research models will take place in a section of the tunnels instrumented to provide data on gaseous radiant heating, ionization and consequent interference with radio transmission. Overall forces on the models will be obtained, along with data on other problems related to extreme flight speeds.

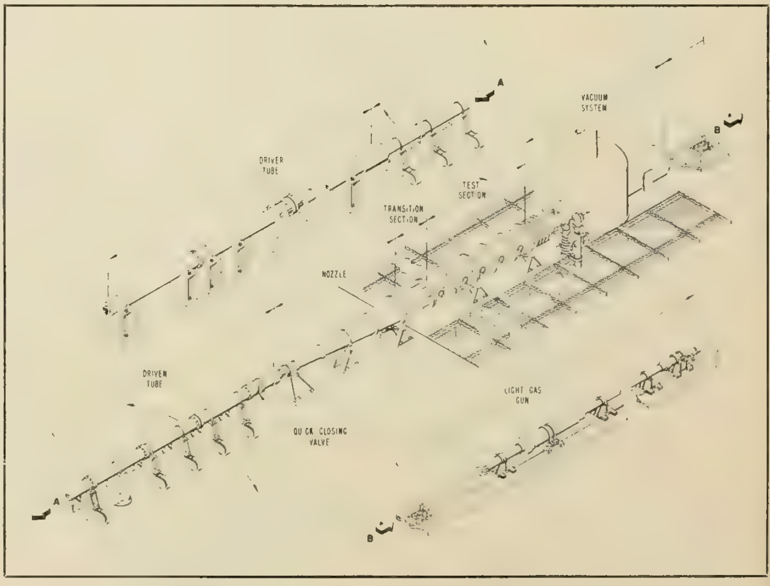
- **Three structures**—The Thiokol contract calls for design, fabrication and installation of three complete tunnels—an aerodynamic, a radiation and a gun-development facility. The propulsion firm is not responsible for gas-gun development.

The aerodynamic tunnel consists of a 17 in. inside diameter driver tube, 70 ft. long, equipped with a breech block at one end and a rupture diaphragm assembly at the other. A 12 in. I.D., 80-ft.-long driven tube is next, with one end connected to a converging-diverging nozzle. The test section will be octagonal, 80-ft. long and connected to a 4,500-cu.-ft. vacuum chamber.

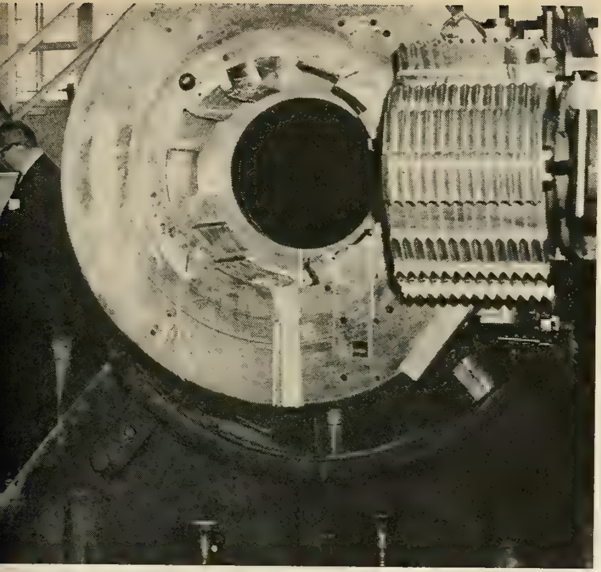
The second tunnel, the radiation unit, is similar but smaller. Its driver tube is 32-ft. long, with an I.D. of 10.5 in. The driven tube is 42-ft. long with an I.D. of 7 in. The nozzle and test section is comparable to the aerodynamic tunnel, except that the test section is only 20-ft. long. The vacuum tank has a volume of about 1,100 cu. ft.

The gun-development range has a main element consisting of a vacuum tank 51 ft. long with a 36 in. I.D. Supports for the light gas guns are part of the Thiokol work.

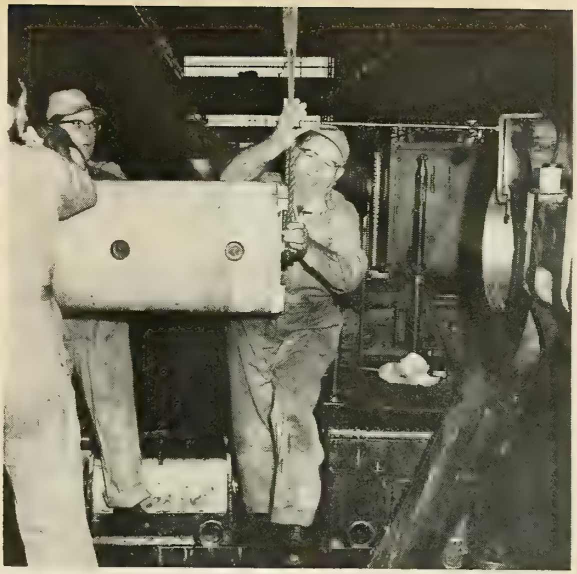
Both the aerodynamic and radiation tunnels have three modes of operation—gunpowder-heating mode, cold helium mode and the stochiometric mode. The design parameters vary with each mode,



SECTIONED schematic of aerodynamic tunnel.



MASSIVE NAVAL guns will be bored and lined at Thiokol's Pocatello plant. Existing breech mechanisms will be used in hypervelocity tunnels to test planetary return re-entry.



WORKMEN ADJUST huge cutting head before reaming operation. Wooden brace fits enlarged barrel and supports cutting head rod. Monolithic liner will be shrink-fitted into tubes.

but the systems must be capable of all three. Pressures up to 30,000 psi will be encountered in the driver and driven tubes. There will be vacuums as low as 0.1 micron in the radiation tunnel and 0.5 in the aerodynamic unit.

Temperatures in the driven tubes will reach 17,000°F. with a peak duration of less than 30 msec.

- **Fast-acting valve**—Thiokol experts say the general design of the system is within the current state of the art, with the exception of a crucial quick-closing valve. This unit, located near the nozzle end of the driven tube, will close and prevent driver gases from entering and contaminating the test section. Helium recovery is also provided by this valve action.

Taking the gunpowder-heating mode as an operating example, the hypervelocity facility initiates a test function with the ignition of a powder charge at the breech end of the driver tube.

The shock wave thus generated will compress contained helium gas, rupturing a single diaphragm at a predetermined pressure. The helium driver gas then compresses air in the driven tube to pressures as high as 30,000 psi.

A mylar diaphragm located at the extreme end of the driven tube ruptures allowing the driven tube gas to flow through the nozzle into the test section.

The explosively operated quick-closing valve cuts off the driver gas flow. The aerodynamic model, launched from the gas gun at the opposite end of the facility, is timed to enter the test section with the oncoming driven-tube gas.

The quick-closing valve is under development at Thiokol's Reaction Motors Div. The unit will have an operating pressure of 30,000 psi, a seal pressure of 15,000 psi and a maximum gas temperature of 1,500°F. Closing time is less than 100 msec.

A ball-valve design was chosen for its characteristic smooth, undisturbed flow—a prime requisite because of the high velocities obtained in the system.

Ball valves have an inherent closing-torque phenomenon between approximately 15 and 88 degrees open—flow through the valve tends to close it throughout most of the valve stroke.

The valve seat will be a stainless steel differential piston held off the ball by a spring in the depressurized condition—or when the valve is open and depressurized. When the valve is rotated to the closed position, downstream pressure will decrease and the piston will move forward against the ball. The greater the pressure differential, the greater the seal. Shaft rotating seals will use piston rings that are stacked to function as labyrinth-type seals. Vent cavities will be provided.

- **Navy guns used**—In a unique approach to driver tube construction, Thiokol is using 16- and 14-in. naval guns, bored to the proper diameter on massive lathes in the firm's Pocatello plant. The former Navy gun facility has some of the largest milling, turning, boring, finishing, plating and heat-treating capabilities in the U.S. One current program involves conversion of a 14-in. Navy gun into a high-pressure test chamber capable of withstanding 30,000 psi.

In fabrication, the guns will be shortened to remove the thin-walled ends and the segments will be flanged together. Existing breechblock mechanisms will be used.

Stainless steel liner replacement will be achieved by heating the entire tube in one of the large vertical furnace pits and shrink-fitting a monolithic liner in place.

The nozzle consists of three main elements—throat, trunnion and diverging section. The throat housing is designed to accept copper inserts. The transition section will be fabricated from steel and fiberglass, with careful maintenance of vacuum-tight joints at the nozzle interface.

Both octagonal test sections will have gradually increasing cross-sectional areas along the longitudinal axis. Four of the flat sides of the unit will house instrumentation windows.

- **Vacuum units**—The vacuum systems for the three ranges will use commercially available equipment. A combination Rootes blower and mechanical pump will act as the roughing stages. Oil-diffusion units will be used to achieve final test section vacuum levels.

The driver and driven tubes will be hydrotested to 45,000 psi levels. The complete coupled unit—consisting of the driver and driven tubes, breech plug, diaphragm assembly housing, quick-closing valve and nozzle coupling—will be included in the hydrotest.

Thiokol acts as systems manager for the Ames facility. Technical management, design, engineering and checkout is handled by the Utah Research and Development Co., a subsidiary of Interstate Engineering Corp. MHD Research Inc. is providing backup in design areas, and analysis as required. ■

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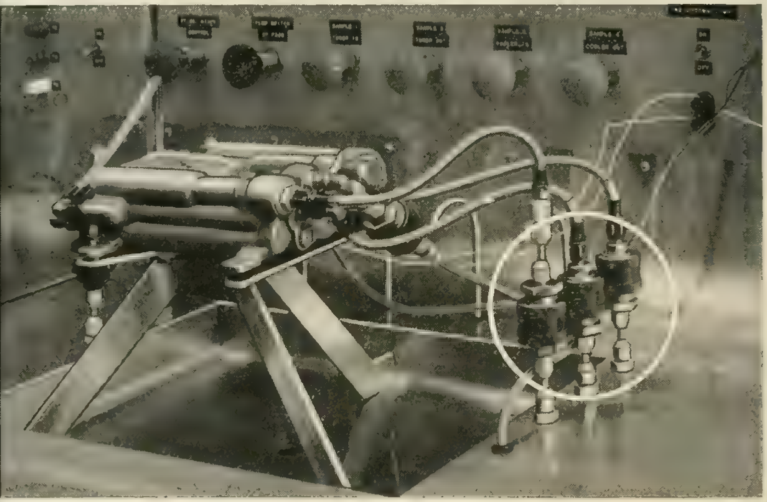

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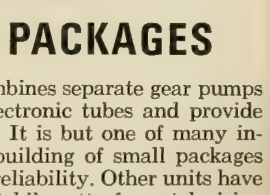

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Agreement on Lunar Surface Broadens

Impact of ultrahigh-vacuum testing on landing vehicle design is cited at Boston meeting; 'fairy castle' structure described

by Michael Getler

IMPORTANT new inputs to design of lunar-landing vehicles may grow out of a recent gathering in Boston of more than 100 top scientists concerned with studies of the structure and material make-up of the lunar surface.

Some of those attending the three-day Lunar Surface Materials Conference late last month report that, while there is still controversy concerning the detailed nature of the lunar surface layer, areas of general agreement are broadening. They say new experimental approaches should yield more usable and realistic data for lunar soil mechanics studies.

The conference was cosponsored by the Air Force Cambridge Research Laboratories (AFCRL) and Arthur D. Little, Inc.

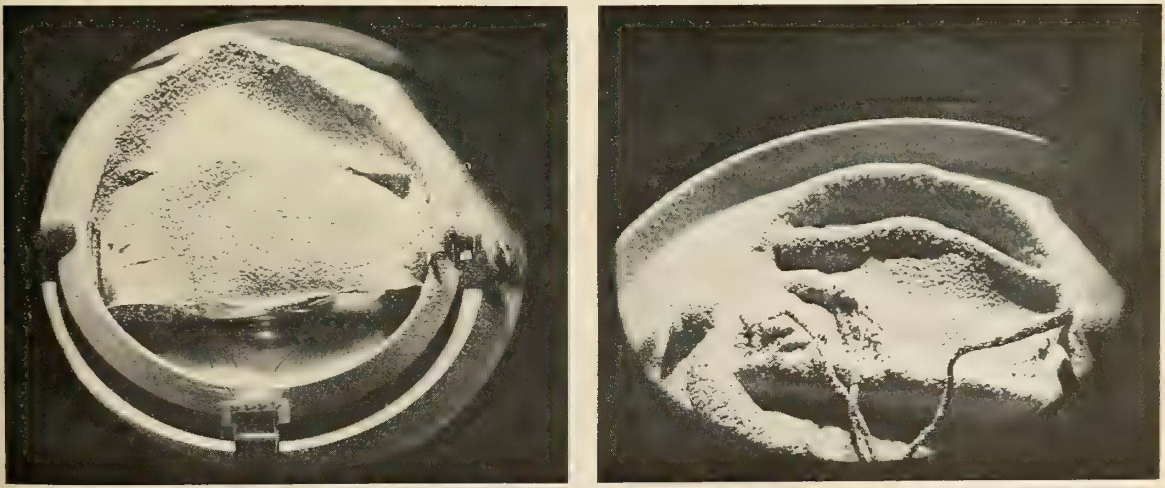
The area of agreement generally focused on the uppermost lunar "dust" layer, including the structure and particle behavior in the ultrahigh lunar vacuum. Theories in both these areas are somewhat complementary—and have led to optimism among some scientists that lunar-landing problems may be less severe than originally anticipated.

There was general support for the detailed description of the lunar surface dust structure presented by Dr. Bruce Hapke of Cornell University's Center for Radiophysics and Space Research. The concept is based on photometric observations of the unique manner in which the lunar surface sharply backscatters light. Hapke, in laboratory examinations of several materials to determine the properties essential for lunar-type scattering, evolved the so-called "fairy castle" structure for the surface layer.

Essentially, this is a loosely compacted, finally divided rock dust layer of unknown depth whose particles, which have an average size on the order of 10 microns, are joined in an immensely complex dendritic structure. Hapke notes that the rock dust on the Moon is darkened, most probably due to hydrogen ion bombardment from solar winds.

- **Photometric limitations**—Hapke emphasizes that photometric properties of the Moon can furnish information concerning only the top millimeter of the lunar surface. However, he says that recent analysis of the thermal components of lunar radiation indicates that large areas of the Moon are covered to a depth of many meters by a substance 20 times as underdense as rock. It is very reasonable, he asserts, to suspect that those underlying materials might be identical with those exposed at the surface.

If subsurface layers are dust, as



LEFT: *Basalt powder used in AFCRL-ADL tests is sieved in air into holder and aluminum boat for thermal conductivity experiments. Wires are to heat source and thermocouple. Note general low angle of repose, and high angle at right rear of holder.* **RIGHT:** *Powder sieved at 10^{-10} mm Hg in vacuum chamber shows significant change. Note 90° angles of repose.*

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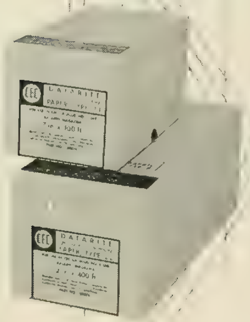

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suggested by Dr. Thomas Gold of Cornell, then the "fairy castle" structures at depth must be capable of resisting the compaction due to the weight of overlying layers.

In laboratory tests, Hapke states, data clearly show that finely divided powders are capable of maintaining themselves in an underdense state to considerable depths on the Moon. Thus, he says, if the radio-thermal analysis is correct, the possibility of large areas of the lunar surface being covered with thick deposits of dust might be given serious consideration.

Though virtually all observers agree that there is dust, the central area of disagreement revolves around its postulated depth and distribution around the Moon. Lined up against the deep, unconsolidated dust theory chiefly espoused by Dr. Gold are other scientists who claim the dust layer is at best locally deep near large depressions and probably much less than a meter thick in level areas.

- **Rubble layer**—For example, a lunar surface model developed by two scientists at AFCRL, Dr. John W. Salisbury and Vern G. Smalley, suggests that the lunar surface layer is composed primarily of "solid" rubble, not dust. This is mainly due to the pulverizing effect of meteoroid impact, which the scientists assert is the most important mechanism involved in producing the surface layer.

Salisbury and Smalley say the rubble is mantled by a layer of fine debris or dust, which they estimate is probably no more than a few centimeters thick over near-level ground, but which may be meters deep in steep-walled depressions.

The AFCRL scientists say the surface layer will be composed primarily of coarse debris ejected from the large craters, with the thickness varying sharply. They estimate an average of at least 63 cm (2 ft.) deep in the highlands. Locally, they note, the rubble is much deeper, especially in the rims of large craters and near the southern shore of Mare Imbrium. Rubble is also expected to be less coarse in the maria.

Roughness of the lunar surface on a meter scale has probably been reduced by five different processes, they report. Two of these—entrapment of meteoroidal debris by the walls of depressions and possible electrostatic transport—would tend to preferentially fill depressions. At the same time, a negative accretion process should tend to maintain a thin equilibrium layer of fine debris on near-level areas. Thus, they assert, the relief of the coarse rubble layer is largely obliterated by the mantle of the fine dust.

Salisbury and Smalley say their model is in agreement with much of the evidence collected to date concerning nature of the surface. The dust layer would have the low density, low thermal conductivity, and low relief demanded by infrared, radio, and radar measurements. It should also have a complex surface, produced by the "fairy castle" arrangement noted by Hapke. If Hapke's prediction of the effect of radiation damage on iron-rich materials is correct, they report, the dust should also have the opacity and low albedo of lunar surface materials.

- **Dust behavior key**—The AFCRL scientists also note the critical importance of dust behavior to a successful lunar landing if the dust is locally deep, which they believe to be the case.

Included in the AFCRL report to the conference were discussions of key experiments recently made in conjunction with ADL in the ultrahigh (10^{-10} mmHg) vacuum chamber. Results of the tests, which were begun in September and included a number of materials, demonstrated that there is a strong adhesion between the fine silicate powder particles at these vacuum levels. This provides a significant strength to the bonds which Hapke describes.

Gross adhesion in these experiments, AFCRL reports, was estimated to be approximately 750 dyne/cm^2 (.01 psi) although the stress at contact points between grains may be as great as 3×10^8 dyne/cm^2 (4.4×10^3 psi). Even greater adhesion between particles is expected on the lunar surface, where radiation cleaning should provide ultraclean surfaces.

Salisbury and Smalley assert that the strength demonstrated so far within the chamber is sufficient to eliminate significant design problems for vehicles and spacesuits.

The AFCRL-ADL tests, some scientists feel, will probably lead to a number of materials tests being re-run by experimenters whose latest findings are based on tests done in chambers evacuated to less severe vacuums (roughly 10^{-6}).

- **Doubts about early work**—One observer, who reports "he has no ax to grind," told MISSILES AND ROCKETS that because most tests to date have been run in these "unrealistic" vacuum levels, "most of the work that has been done to date has a very doubtful significance, and in fact a misleading significance, for LEM (Lunar Excursion Module) designers."

It has been known for some time, scientists report, that lunar surface pressures must be less than 10^{-9}, but it is only recently that the equipment needed to begin achieving these levels has become available.

"When people first started making soil mechanics tests they couldn't reach these 10^{-9} and 10^{-10} levels," a scientist states, "and many hoped that tests made at intermediate vacuums would be valid at still higher vacuums with no appreciable change. The fact is," he said, "that there is an appreciable change, but this doesn't shock anybody. There is now a realization of what many people predicted."

Though difficulties arise due to the greater adhesion characteristics of lunar dust particles at the higher vacuums, Salisbury maintains that this property remains much more a boon to the lunar landing effort than a hazard.

At lunar surface pressures, physically adsorbed gas layers are removed and surfaces become essentially cleaner, with greater resultant adhesion between clean particles. If lunar dust is stirred up by either a landing craft, a roving vehicle, or a mobile astronaut, particles could adhere to, and foul, moving parts and obscure camera lenses and viewing areas.

To deal with this, scientists say an artificially supplied gas flow across the surface could be introduced to act as a slightly contaminated shield to prevent clean surface particles from adhering to clean spacecraft parts. Probably a less complex solution involves coating of surfaces with a very-low-vapor-pressure oil or transparent silicon grease.

• **NASA programs restudied**—The controversy over the lunar surface and subsurface structure and its ability to support a spacecraft landing is stirring up considerable interest within NASA planning groups. Proposals are in on a possible Lunar Reconnaissance Module (M/R, June 3, p. 9). Also being funded are studies of possible probe launchings towards the lunar surface from an orbiting *Apollo* vehicle.

The value of inputs from *Ranger* and *Surveyor* is viewed as doubtful by some scientists. However, with *Surveyor* it is mostly a question of numbers: *Surveyor* is limited in terms of providing an accurate lunar surface profile because it makes only point measurements and its probes will go down into the surface to a maximum depth of about one meter. Since it is virtually certain there will be local variations in the lunar terrain and the depth of the dust layer, the question of the number of probes launched and operating successfully becomes especially important. Dr. Salisbury, for example, feels that LEM designers could design for extremes based on data received from *Surveyor* if more than two or three vehicles are used.

Among other highlights of the meeting was a note of caution sounded by Professor Zdenek Kopal, of the University of Manchester, England. Prof. Kopal warned of "suspect" photometric data supplied by the USSR and used in some concepts now being developed in the West. Kopal said some of this data is 25-30 years old. ■

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...to track, monitor, and measure spacecraft and missile performance of every launch at the Atlantic Missile Range.

For instrumentation engineers with Pan Am's Guided Missiles Range Division, this means the planning and design of new sensor systems to meet the demanding radar and telemetry requirements of each new mission—Gemini, Apollo, Satellites, Space Probes. These next generation instrumentation systems will provide greater coverage, accuracy, mobility, reliability and automated real-time data delivery.

Examples of diverse approaches being taken to achieve such systems are:

- a new CW doppler range-rate tracking system that measures missile and spacecraft velocity with accuracy of 0.5 fps.
- pulse doppler radars that measure range rate to 0.1 fps.
- large high-gain (85 ft. diam.) wide-band (130-2300 mc) automatic tracking antenna systems
- advanced, universal pulse code modulation (PCM) ground systems (bit rate from 1 to 1 million bits per second).

Engineers interested in joining in this effort are invited to write in confidence to Dr. Charles Carroll, Dept. 56F-2.

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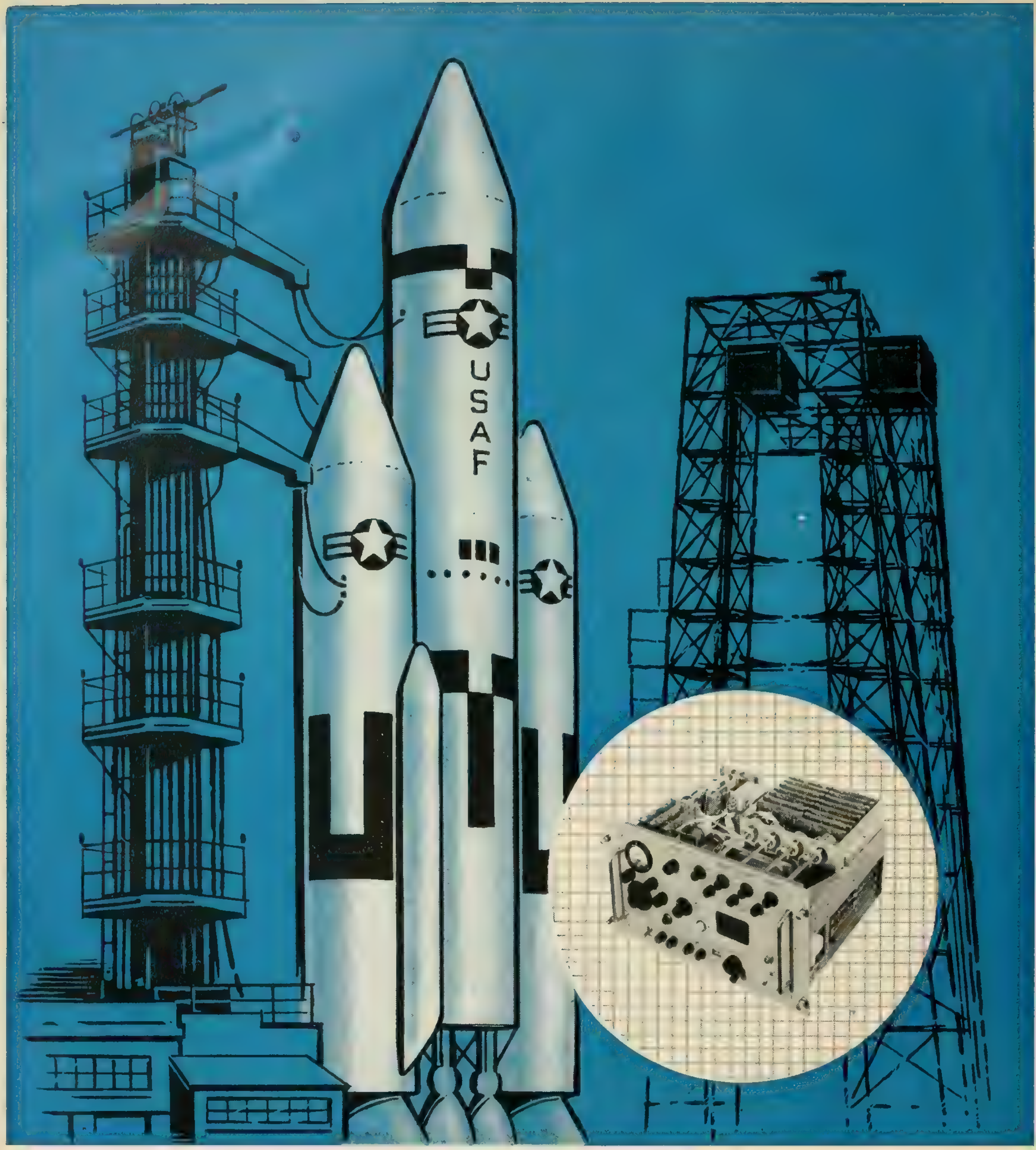

Stool Pigeon for the Big Birds. Missile borne beacons scheduled to ride the big birds in the Titan III and Polaris evaluation programs are being thoroughly checked out by Sperry C-band beacon test sets. Pre-testing assures proper beacon flight performance. □ Inherent self-test capabilities of this new C-band beacon tester assure extreme accuracy and enhance the value of the data collected during test flights. Sperry's proven ability in producing precise test equipment guarantees peak performance. □ This advanced unit will satisfy virtually any present C-band beacon test requirement. Sets are available for two-pulse code systems and coding can be extended to all 3- and 4-pulse systems in conformance with IRIG specifications. □ For complete information and data on C- and S-band beacon test sets, write or call *SPERRY MICROWAVE ELECTRONICS COMPANY, Clearwater, Florida.*

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GE-developed Laser System Offers High Pulse Rate

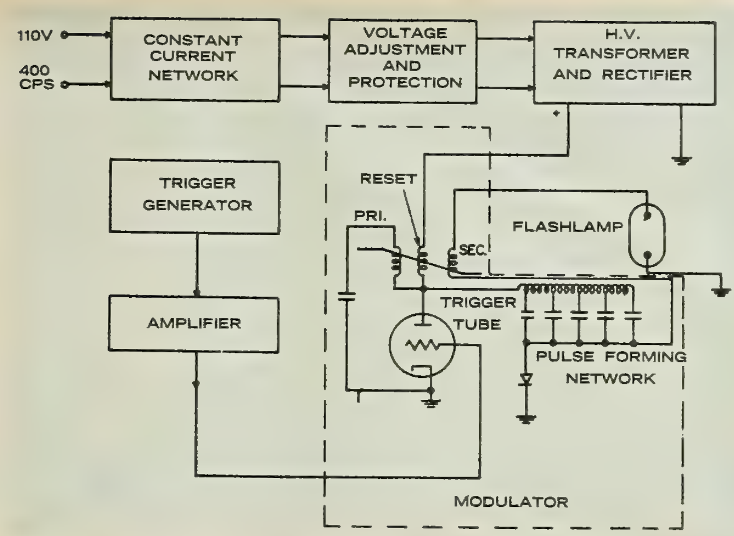


DIAGRAM of power supply for laser tracker being developed for BuWeps.

A LASER TRACKER being developed by General Electric Co. for the Navy will offer a pulse rate capability four times that of existing state-of-the-art laser systems.

The laser detection and ranging system will first be designed for use against airborne targets. Obvious growth capability is toward space targets with the system serving as augmentation for more conventional radar trackers.

It is being developed at the company's Syracuse Electronics Laboratory for the Bureau of Naval Weapons under the direction of GE's Missile and Space Div., Valley Forge, Pa., Space Technology Center.

GE's efforts in this field are an outgrowth of its developing the laser tracker that soon will be used from Wallops Island Station with NASA's *S-66* polar ionosphere beacon satellite and the studies associated with NASA's long-range laser interplanetary communications.

The system will produce a pencil beam with a pulse rate of 40 pps (four times better than the present 10 pps of other systems.)

First deliveries are now being made under the $54,000, six-month contract.

The GE laser, designed for an airborne weapon-control system, will be capable of long-term operation for tracking targets traveling at relative velocities exceeding "several thousand feet per second."

Present units, cooled by forced ambient air, could offer greatly increased pulse rates, developers say, with the addition of a more efficient cooling system.

The 80-lb. system, including power supply, is a low-threshold laser employing a calcium tungstate rod (0.250 in. dia. x 2 in. long), with neodymium doping. Pumping power is from a high-power flash lamp. Returned signals, which are in the infrared range, are picked up by a very-high-resolution optical receiver.

- **The optical system**—A standard flash lamp (E.G.G. FX 38A) and laser rod are located close together in the GE design. They are symmetrically displaced from the axis of a circular cylinder with ⅜-in. center-to-center spacing.

A 2-in. dia. housing is used. At the end of the laser rod, two small tubes are provided containing the external mirrors forming the optical resonant cavity. When the laser material is inserted, the focal point of both mirrors is identical.

An auxiliary lens is used to collimate the diverging laser output beam.

- **Cooling and power simplified**—With forced-air cooling, temperatures up to 130°C. have been measured on the laser-rod surface with no apparent decrease in efficiency. A 19,000-rpm Rotron vane-avial blower is used.

The power supply (see diagram) was designed to obviate a triggering electrode on the flash lamp. Maximum pulse energy of 30 joules is required. To permit reliable triggering and to prevent self-breakdown at the high temperature and operating rate, a ceramic hydrogen thyratron is series-connected with the lamp and the power supply. The 70-lb. power supply requires a 110-v, 400-cps source.

- **Laser output**—Peak output powers, GE developers say, have been measured at above 1 kw with energies above 0.03 joules. Pulse lengths of 35 μsec have been achieved with continuous operation at 10 pps. Average power was 300 mw. Maximum efficiency was about 0.1%. Beam collimation to roughly 10 milliradians was obtained, scientists say.

Improved end reflectors will produce up to 0.1 joule.

Higher pulse rates (up to 40 pps) have been obtained using calcium tungstate rod.

- **System limits**—The present laboratory design is limited by several factors, say GE designers.

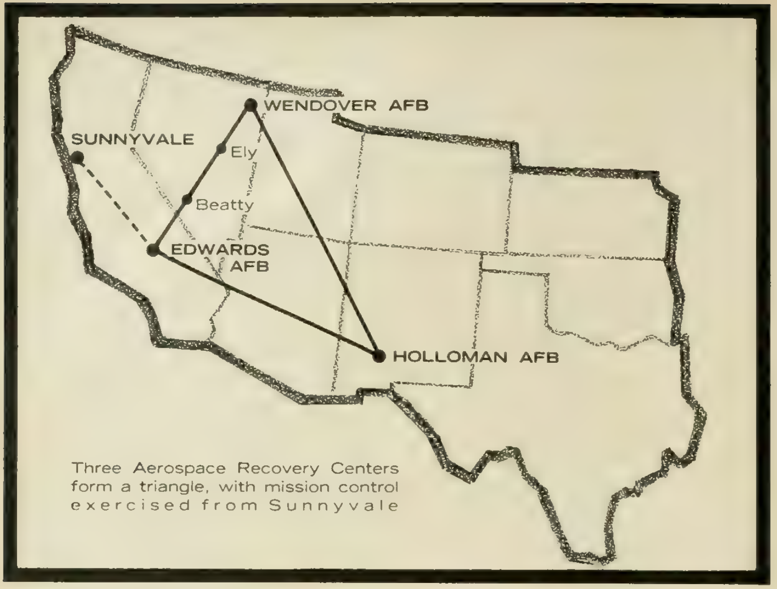
Cooling efficiency must be improved to permit increasing the power input capability per unit length. Probably the best approach would be to enclose the rod and lamp in separate tubes and use forced air or liquid cooling through them, designers say.

At present peaks and energies, mirror and anti-reflector lives are limited to roughly one hour. While work is progressing in many companies on improving optical coatings, the elimination of coatings in the resonant cavity might be desirable. Reflective losses, for example, might be reduced by employing totally reflecting prisms with output coupling provided by reflection from a suitably located prism in the resonant cavity.

Finally, a longer laser rod probably could help increase output energy per pulse, according to GE scientists.

Developers believe they can build a laser that will deliver a one-joule output at 10 pps with their present design. If a higher rate is needed, 30 pps can be obtained with a 0.1-joule output.

Q-switching techniques could be incorporated with the existing developmental laser system for applications requiring shorter pulse lengths (10-50 nanoseconds). ■



Three Aerospace Recovery Centers form a triangle, with mission control exercised from Sunnyvale

No Wellsian spaceports . . .

Air Force Picks Three Sites for Space Landings

Edwards, Holloman, Wendover AFB's to retrieve manned spacecraft; data link to Sunnyvale obviates big facility

THE AIR FORCE has decided to recover future manned spacecraft at Edwards, Holloman and Wendover Air Force Bases, with all mission command and control being exercised by the Satellite Test Center (STC) in Sunnyvale, Calif.

The decision, approved last month by AF headquarters, was made by AF Systems Command after several studies of all possible sites in the continental U.S. Net effect of the action is to eliminate the need for a large, expensive "spaceport" for tracking and recovering space vehicles on their final landing approaches.

Under the plan, Edwards AFB, Calif., Holloman AFB, N.M., and Wendover AFB, Utah, will be used as prime recovery areas, with Edwards likely to be the first choice. A data link allowing use of the existing computer setup at the Sunnyvale Statellite Test Center will be established, and mission control will be exercised from the STC for the entire orbit and recovery phases of each mission.

Final retrieval of vehicles and crews will be delegated to units at each base, as necessary, similar to the way NASA gives the *Mercury* retrieval job to Navy units while retaining its own control of missions.

Air Force spokesmen said the first program to operate under the arrangement will be the *X-20 Dyna-Soar* in its air-launched phases. The *X-20* will be dropped near Wendover AFB and glide along the instrumented leg of the triangle to Edwards. Later flights involving orbital missions will cause data inputs to come to the STC from tracking and communications stations around the world, and computer links will then tie the three recovery sites together with the Mission Control Center (MCC) at Sunnyvale.

Air Force requirements for the setup include possible modification of radar now at the three recovery sites to allow longer range, and display boards to give the recovery sites information on mission status. Basic tracking information will be gathered at such stations as Pt. Arguello, Pt. Mugu and Hawaiian facilities, transmitted to STC and computed to give de-orbit point, re-entry trajectory and landing point data. This information will be relayed to the selected recovery site.

- **Economy stressed**—AFSC spokesmen emphasized the economy inherent in the chosen approach, which was selected over a number of proposals involving construction of large "spaceports" in the H. G. Wells tradition.

"Even if we started from scratch with new facilities to handle these vehicles with completely self-sufficient equipment, the maximum cost we've estimated is $29.932 million," a program officer said.

Equipment, personnel and other resources required for the anticipated military spacecraft will be added as the programs and missions are added, AFSC said. The STC facilities, as now constituted, can be expanded on an incremental basis as programs and responsibilities are assigned to the Air Force.

The decision comes little more than a year after Gen. Bernard A. Schriever, AFSC Commander, instituted a search for the answer to the Air Force's anticipated need in aerospace recovery capabilities.

Represented on the study committee were all affected centers and commands, as well as the Rand and Aerospace Corporations. Individual reports, proposals and studies were generated in addition to the AFSC effort, and most reflected local self-interest.

(In one exchange, Edwards noted that White Sands Missile Range was near the Mexican border and that a 100-mile landing error could put the spacecraft in Mexico. It failed to mention that a similar error while attempting to land at Edwards could put the spacecraft in downtown Hollywood, Death Valley or the Pacific Ocean. White Sands, meanwhile, pointed out that Edwards is in an earthquake area.)

- **NASA recovery area**—The presence of some NASA officials in the *X-20* program is seen by the Air Force as constituting NASA participation in the selection of the recovery area and planned procedures. The reason there was no major NASA participation in the selection is that most of the space agency's requirements are peculiar to its missions, and it could not use the AF bases involved.

Because of required launch angles and resulting orbital inclinations, the NASA recovery area will almost surely be in the southernmost tip of Texas. The *Gemini* launch angle for the 14-day mission, it is believed, will be virtually 90 degrees due east of Cape Canaveral, giving an equatorial inclination of less than 30 degrees. Edwards and Holloman are above this latitude. ■

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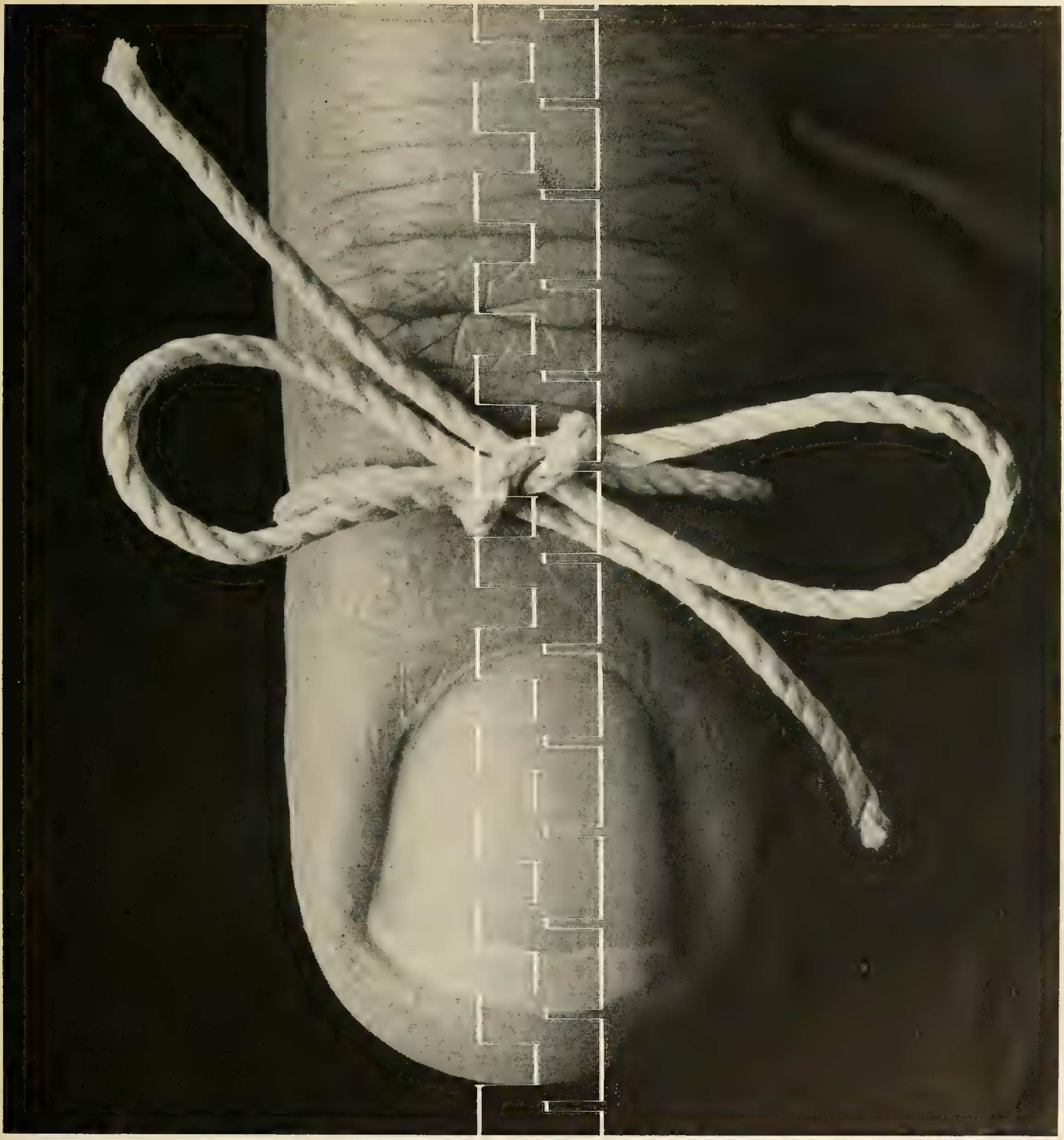

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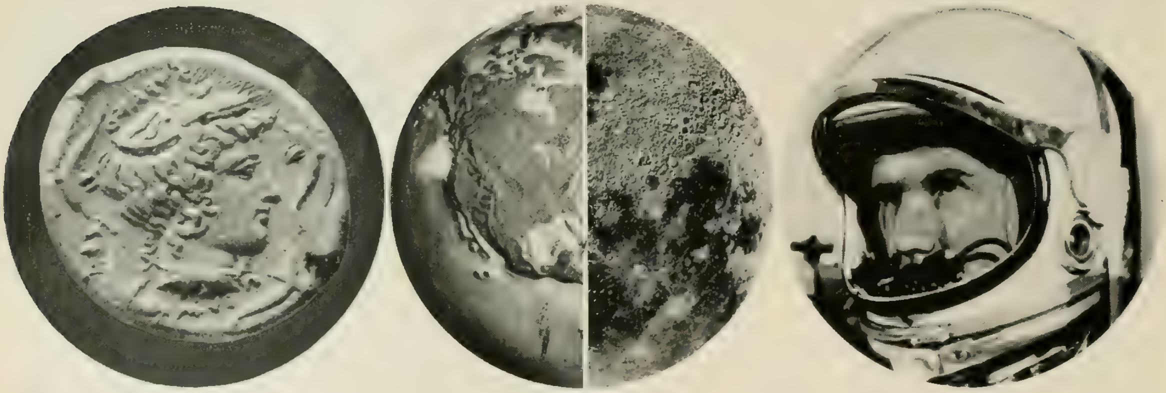

ACT NOW FOR ASSIGNMENTS ON PROJECT APOLLO

> *"The requirement for the Integration and Checkout program arises from the unique characteristics . . . of Apollo . . . which distinguishes it from other projects. These include (1) the serious consequences of failure as measured in terms of national prestige, human life and cost; (2) the complexity . . . in terms of the technology required and the numbers and types of industrial contractors involved; and (3) the long period of operations in the space environment with no significant maintenance or repair possible."*
>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

General Electric's Apollo Support Department has been selected to assist NASA in the integration support, checkout and reliability assessment of the Apollo system. Without doubt, it takes an unusually mature and competent man to perform under the realization that his individual work can be of significant importance to such a program.

If you are the kind of person who thrives on such responsible work, there's a place for you with General Electric. We've already put together the most impressive team ever assembled in the General Electric Company for this program . . . however, there are *many* opportunities still available to the *right* men. From the listings below you can determine your own opportunities. **Contract Programs:**

CHECKOUT . . . work consists of two distinct parts. First, a continuation of current engineering study efforts to provide NASA with checkout systems analysis, standardization studies, an integrated space vehicle checkout system specification, studies of test procedures, the application of advanced checkout techniques to Apollo, and system checkout engineering support at NASA field centers. Second, provision of checkout equipment to be included within the integrated launch control and checkout system.

RELIABILITY ASSESSMENT . . . effort includes assisting NASA in assessing overall mission reliability and safety levels, implementing a reliability and failure data system, and reviewing reliability and quality procedures and controls.

INTEGRATION SUPPORT . . . assist in identification and documentation of equipment and procedure interfaces within the Apollo project. Studies of integration methods and their application to Apollo including configuration control, and data handling.

Engineering experience required in: SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

- ☐ **Complex Systems Design**
- ☐ **Guidance Control Systems**
- ☐ **Telemetry Systems**
- ☐ **Electronics Packaging Design**
- ☐ **Logic Design**
- ☐ **Human Factors**
- ☐ **Systems Engineering**
- ☐ **Cryogenics**
- ☐ **Engineering Writers**
- ☐ **Computer Engineering**
- ☐ **Computer Programming**
- ☐ **Data Processing Display**
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- ☐ **Data Analysis**
- ☐ **Launch Facilities Systems**
- ☐ **Instrumentation & Simulation Systems**

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Write today to: Mr. P. W. Christos, Apollo Support Department, General Electric Co., Support Building, Room 73-H.P.O. Box 2500, Daytona Beach, Florida. (Your inquiry will be held in strict confidence. Please include your salary requirements.)

APOLLO SUPPORT DEPARTMENT
A Department of the Command Systems Division

GENERAL ELECTRIC

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New Firms and Divisions

Cook Electric Co., Morton Grove, Ill., aerospace, electronics and communications firm, has integrated three previously-independent divisions into its Cook Technological Center Div. Cook Research Laboratories, Inland Testing Laboratories and Air Mod divisions will operate as departments of CTC. . . . *Vitta Corp., Wilton Conn., has been formed to produce and further develop transfer tapes for use in the electronics industry. The new firm will operate under exclusive license granted by Machlett Laboratories, Inc., subsidiary of Raytheon Co. Vitta is also aiming at R&D development work in the electronics and microelectronics industries.* . . . Pax Electronics Co., Inc., Woodside, N.Y., a subsidiary of Space Age Materials Corp., has established a new Electronic Photography division to develop and manufacture electronic photographic equipment. . . . *Television Shares Management Corp., Chicago, is changing its name to Supervised Investors Services, Inc. SIS will continue TSM's function of providing advisory and distribution services to Television-Electronics Fund, Inc., a mutual fund specializing in electronics and aerospace stocks.* . . . Cryogenics, Inc., Alexandria, Va., manufacturer of instruments for low temperature applications, has announced formation of a Chemical Controls division. Function of the new division will be to direct sales and application engineering efforts for cryogenics hardware.

International

Control Data Corp., Minneapolis, has purchased a majority of the outstanding shares of Electrofact N.V. of Amersfoort, The Netherlands, in exchange for 39,950 shares of CD common stock. Electrofact manufactures and markets measuring, recording and control devices, and systems for use in industrial processes. In addition to continuing its present activities, Electrofact will provide facilities for manufacturing CD computing equipment in The Netherlands, giving CD computer manufacturing capabilities within the Common Market area. . . . *FMA, Inc., El Segundo, Calif., and Société Generale de Belgique, a European financial company, have formed a joint Belgian-American firm, Compagnie Eurpéene pour la Technologie de L'Information, in the field of automatic information processing.*

Industry Facilities

Cameron Iron Works, Inc., Houston, has installed a consumable vacuum remelting plant, supplementing its existing air melt furnaces to produce super-clean alloy steel and heat resistant alloys, primarily for missile/space applications. . . . *Battelle Memorial Institute, Columbus, Ohio, has established a Mechanical Reliability Research Center for long-range research to advance state of the art in mechanical reliability.* . . . The Unitec Corp., Baltimore electronics engineering firm, is moving to a new 31,000-sq.-ft. building as part of a general expansion plan. With acquisition of the John B. Adt Co., a processing machinery manufacturer, the move will provide additional capability in the applied electronics field. . . . *Westinghouse Electric Corp. will lease a new 100,000-sq.-ft. plant to be built north of Towson, Md., by Maryland Properties, Inc. Occupancy is to take place early next year. Eventually the plant is to employ about 600 in electronic equipment test activities as a support to the Air Arm and Electronics divisions located near Baltimore's Friendship International Airport.* . . . Bendix-Balzers Vacuum, Inc., has leased 30,000 sq. ft. of office, manufacturing, laboratory and warehousing facilities in Rochester, N.Y. Bendix-Balzers is controlled by the Bendix Corp. and was established jointly with Balzers A.G., Liechtenstein, to build and sell high-vacuum equipment for scientific, industrial and commercial applications.

Potpourri

A missile/space industry exhibit will go on display June 17 in the Florida Showcase at New York City's Rockefeller Plaza. Eighteen major aerospace companies are sponsoring the exhibit, which was arranged by the Atlantic Missile Range Public Relations Assn. The exhibit will remain in the Showcase for one month, then go on tour before returning to New York for a two-year stay at the World's Fair. . . . *The General Electric Co. and the Polytechnic Institute of Brooklyn have announced a graduate engineering program aimed at increasing the effectiveness of engineering education and bolstering the future position of the U.S. industry in world markets. The new four-year course is a combination of advanced academic education and on-the-job internship in engineering design, culminating in an engineering doctorate degree.* . . . The Link Div. of General Precision, Inc., has presented fellowships to two future Air Force officers at the 1963 Arnold Air Society National Conclave in Buffalo, N.Y. The awards will allow continuance of post-graduate engineering studies for Chester J. Gabriel of Princeton University and George D. Matthew of Cornell University. The fellowships were established in 1954 by the Link Foundation to promote and advance aerospace research, training and education. . . . *A cross-licensing agreement on a "package of advance technologies" has been concluded between Sanders Associates, Inc., and Western Electric Co. The agreement extends to all American Telephone and Telegraph-associated companies, is retroactive to July 1, 1962 and provides for Sanders to receive royalty payments for use of SA's patents on FLEXPRINT printed circuitry and TRI-PLATE microwave strip transmission line. Sanders will pay royalty to Western Electric for use of WE's patents on semi-conductor and thin film devices.*

GUIDANCE
AND
CONTROL
(Manned Spacecraft, Research, Advanced Systems)

North American Aviation's Space and Information Systems Division has several assignments of exceptional scope and interest available to qualified engineers and scientists.

Tasks in the Guidance and Control Department range from actual hardware evaluation to theoretical postulation of advanced systems.

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ASTRODYNAMICS: Orbit prediction and determination. Stability analysis and effects of model uncertainties. ORBITAL MECHANICS: Atmospheric and Space trajectory analyses. Development of design and operational criteria. Reference trajectory generation.

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STABILIZATION & CONTROL

Servomechanisms analysis • Advanced dynamics • Analog and digital computer simulation • Linear and non-linear systems analysis • Systems design analysis and mechanization • Sun seekers, horizon scanners, rate inertial gyros • Thrust vector control studies.

If you are interested in associating with a company whose long experience and proven capability provides a broad perspective of past, present, and future space missions and you feel you can contribute to progress in the field of guidance and control, you are invited to investigate further by writing in confidence to:

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SPACE & INFORMATION SYSTEMS DIVISION
North American Aviation

AWARDS

AIR FORCE

$7,400,000—**Anaconda Wire & Cable Co.,** Hastings-on-Hudson, N.Y., for additional production of communication cable linking for *Minuteman* ICBM sites at Whiteman Air Force Base, Mont.

$5,900,000—**Defense Electronics, Inc.,** Rockville, Md., for work on a telemetry receiving and storage subsystem.

$1,863,605—**International Business Machines Corp.,** New York City, for work on a classified project.

$1,781,430—**General Precision, Inc.,** Tarrytown, N.Y., for development of a spaceflight simulator trainer. Work to be done at Binghamton, N.Y.

$1,300,000—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for modification kits and related equipment for the *Hound Dog* missile.

$1,000,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for *Minuteman* first-stage motors.

$35,100—**Digital Equipment Corp.,** Maynard, Mass., for decoder kits for use in decoder circuitry at Air Force Systems Command's Missile Development Center, N.M.

$28,300—**Alloyd Electronics Corp.,** Cambridge, Mass., for design, fabrication and testing of a flyable quadrupole mass spectrometer suitable for use in rocket and satellite vehicles.

ARMY

$3,900,000—**Aerojet-General Corp.,** for work on a classified project. Work to be done at Downey, Riverside and Fullerton, Calif.

$3,500,000—**Western Electric Co.,** New York City, for production of *Nike-Hercules* missile modification kits and guidance equipment. Work to be done at Greenboro and Burlington, N.C.

$2,852,675—**International Business Machines Corp.,** White Plains, N.Y., for electronics equipment. Work to be done at Poughkeepsie, N.Y.

$2,100,000—**Oneida Electronics, Inc.,** Yorkville, N.Y., for communications equipment.

$2,000,000—**Ampex Corp.,** Redwood City, Calif., for electronic equipment production.

$2,000,000—**Martin Co., Orlando Div.,** Orlando, Fla., for engineering work on the *Pershing* missile.

$1,500,000—**Webcor, Inc.,** Chicago, for electronic equipment production.

$1,300,000—**Lockheed Aircraft Corp.,** Redlands, Calif., for research and development work on solid propellant rocket fuels.

$1,100,000—**Farmers Tool and Supply Co.,** Denver, Colo., for shipping containers for *Nike-Hercules* missile system.

$1,000,000—**Hayes International Corp.,** Birmingham, Ala., for production of *Pershing* missile trainers.

$592,800—**Peter D. Kiewit Sons Co.,** for *Minuteman* ICBM launch facility at Vandenberg Air Force Base, Calif.

$500,000—**Martin Co., Orlando Div.,** Orlando, Fla., for open-end hardware re-supply of space parts for Martin-built Army weapons and air defense systems.

$289,600—**Aerojet-General Corp.,** Sacramento Calif., for *Hawk* XM22E8 rocket motors.

$262,000—**Western Electric Co.,** New York City, for *Nike-Hercules* missile spare parts.

$159,300—**Sperry Rand Corp., Sperry Utah Co. Div.,** Salt Lake City, Utah, for engineering changes on *Sergeant* missile equipment (2 contracts).

NAVY

$17,700,000—**Thiokol Chemical Corp.,** Bristol, Pa., for production of *Bullpup* missile engines.

$10,390,345—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for continued research and development on the *Polaris* missile system.

$7,800,000—**Hercules Powder Co.,** Rocket City, W.Va., for additional research and development on solid propellants for missiles.

$4,000,000—**Sanders Associates, Inc.,** Nashua, N.H., for production of classified electronics equipment.

$3,500,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for production of MK38 rocket motors for the *Sparrow III* missile.

$3,389,501—**Martin Marietta Corp.,** Orlando, Fla., for *Bullpup* wings, canards, center sections, engine adapters, data design, shipping containers and dummy missiles.

$1,500,000—**General Telephone and Electronics Corp.,** Mountain View, Calif., for development and production of electronic direction-finding equipment.

$1,300,000—**University of Washington,** Seattle, for procurement and installation of an interim underwater tracking range for use in anti-submarine warfare research. Work to be done at St. Croix, Virgin Islands.

$985,900—**Aerojet-General Corp.,** Sacramento, Calif., for MK6 rocket motors for the *Sparrow III* missile.

$553,900—**Minneapolis-Honeywell Regulator Co.,** Hopkins, Minn., for *Asroc* missile depth charge adaption kit.

$505,000—**Vitro Corp. of America,** Silver Spring, Md., for engineering work on the *Tartar* missile system.

$400,000—**F. J. Stokes Corp.,** Philadelphia, for design and building of an extensive space-simulation facility for pre-launch reliability-checking of Navy satellites.

NASA

$15,538,348—**Brown Engineering Co.,** Huntsville, Ala., for varied engineering services with several Marshall Space Flight Center divisions.

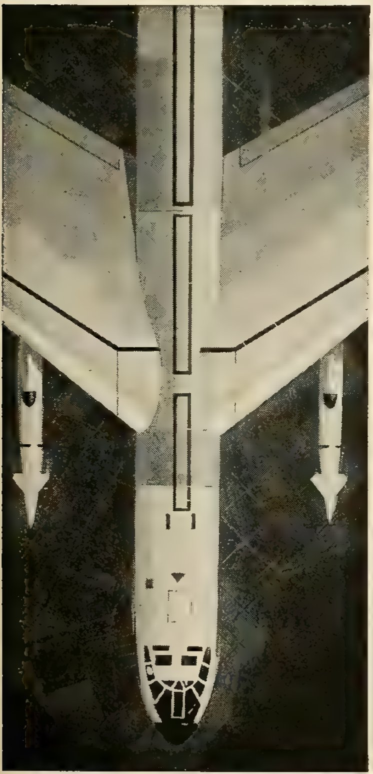
$10,782,744—**Hayes International Corp.,** Huntsville, Ala., for fabrication and engineering services for the Marshall Space Flight Center

$949,000—**Westinghouse Electric Corp.,** Pittsburgh, for design and delivery of the main drive system for the flight acceleration facility to be built at Clear Lake, Tex.

$891,000—**New Mexico State University,** University Park, N.M., for research and developmen support to sounding rocket and Minitrack network.

DIVERSIFIED ELECTRO-HYDRAULICS

BRAKE SHOE'S AEROSPACE DIVISION IS PROVIDING THE ADVANCED PRODUCTS AND SYSTEMS DEMANDED BY AN EVER-WIDENING TECHNOLOGY. The Aerospace Division of American Brake Shoe offers a wide range of compatible hydraulic and electronic products. These products, coupled with the proven ability to imaginatively combine them into sophisticated systems, provide a single responsibility source for power and control of hydraulics for land, sea, air, and space. The Aerospace Division backs this capability with a full staff of factory-trained field engineers ready to serve you in principal U. S. cities, as well as in Canada and Europe. General Offices: 3151 West Fifth St., Oxnard, Calif. • Europe: Aerohydraul, GmbH, Wiesbaden-Biebrich, West Germany • Canada: Jarry Hydraulics Ltd., Montreal, P.Q. **AEROSPACE DIVISION / AMERICAN BRAKE SHOE COMPANY**



A Kellogg pump, a product of the Aerospace Division of American Brake Shoe, is an important part of the Garrett-AiResearch constant-speed drive—an efficient power source for aircraft cabin air compressors.

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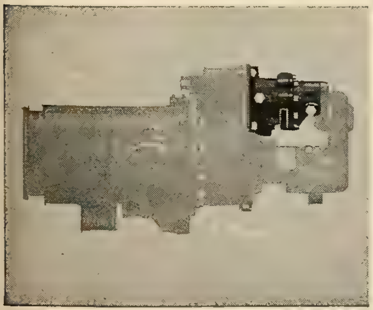
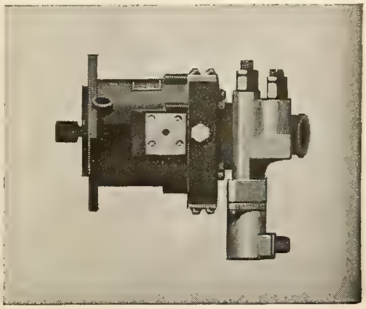
The Kellogg AP6VSC-6 pump, a single-stage, cam-actuated unit, is standard equipment on high-performance military aircraft and the Saturn I missile. The US Army's Chinook helicopter, produced by Boeing's Vertol Division, uses this pump as well as landing gear from Brake Shoe's Canadian subsidiary, Jarry Hydraulics, Ltd.





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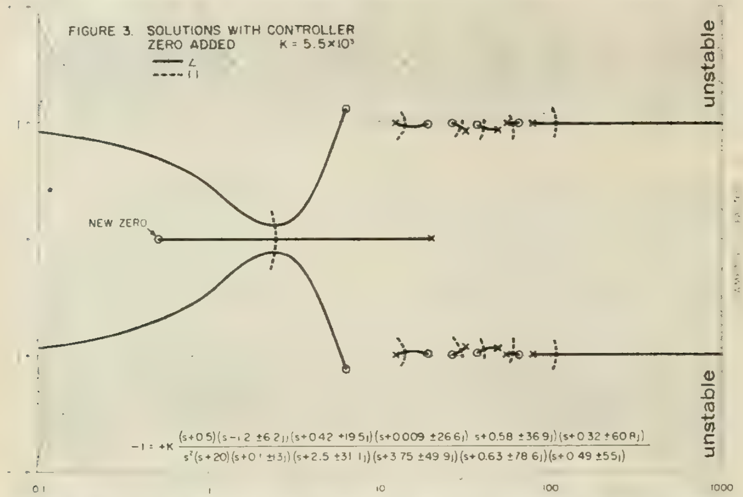
FIGURE 3. SOLUTIONS WITH CONTROLLER ZERO ADDED K = 5.5×10³
unstable
NEW ZERO
unstable
−1 = +K (s+0.5)(s−1.2 ±6.2j)(s+0.42 ±19.5j)(s+0.009 ±26.6j)(s+0.58 ±36.9j)(s+0.32 ±60.8j) / s²(s+20)(s+0.1 ±13j)(s+2.5 ±31.1j)(s+3.75 ±49.9j)(s+0.63 ±78.6j)(s+0.49 ±55j)
0.1
1
10
100
1000

$$-1 = +K\frac{(s-1.2 \pm 6.2j)(s+0.42 \pm 19.5j)(s+0.009 \pm 26.6j)(s+0.58 \pm 36.9j)(s+0.32 \pm 60.8j)}{s^2(s+20)(s+0.1 \pm 13j)(s+2.5 \pm 31.1j)(s+3.75 \pm 49.9j)(s+0.63 \pm 78.6j)(s+0.49 \pm 55j)}$$

Analysis of the Structural Resonances of a Missile

Illustrated above is an ESIAC root-locus analysis of the characteristic equation of a closed loop system. This problem was submitted by an ESIAC user in the missile field and is discussed in detail in a current series of bulletins dealing with typical applications of the ESIAC® Algebraic Computer. Note that the problem contains 23 singularities. Shaded areas on the graph sheet represent the unstable portion of the log s plane. K is the varied parameter.

The ESIAC is a complete, complex variable analyzer/plotter. With it, the designer works directly in terms of the poles and zeros which state his problem. Even very complex equations can be programmed in an hour or less, solutions achieved or new parameters established in a matter of minutes. As a powerful "two-dimensional slide rule" for the complex plane, the ESIAC provides an unparalleled feel of all facets of the system being designed, solves in hours problems that would take days by conventional methods. Cost is less than the annual salary of a design engineer.

Write on your company letterhead for the complete discussion of the problem illustrated above and your copy of "Time and Complexity," a definitive 26-page brochure describing in detail the theory, operation, time-saving advantages, problem-solving applications of the ESIAC in dynamic systems design.

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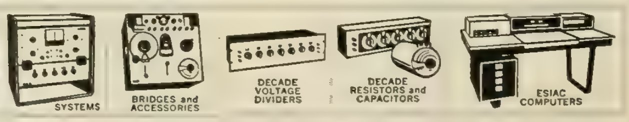

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$258,800—**University of California**, San Diego, for x-ray astronomy experiment to go on the *S-57* satellite.

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$200,000—**David Clark Co.**, Worcester, Mass., for *Gemini* space suit program.

$149,000—**Goodyear Aircraft Corp.**, Akron, Ohio, for inflatable paraglider models.

$120,000—**Telecomputing Corp.**, San Diego, for development of elastic recovery concept for expandable space structures.

$110,600—**California Computer Products, Inc.**, Downey, Calif., for grid point equipment for use on the *Nimbus* satellite.

$98,000—**Ford Motor Co., Aeronutronic Div.**, Newport Beach, Calif., for study of a Mars excursion module.

$97,000—**Sylvania Electronic Products, Inc.**, Waltham Mass., for study plan for collection of weather and oceanographic data from unmanned weather stations, buoys and balloons.

$85,000—**American Machine and Foundry Co., Advanced Products Group**, Stamford, Conn., for steering controls and electric power system for the *Saturn S-1C* stage transporter.

$84,000—**Ionics, Inc.**, Cambridge, Mass., for the development, design, and fabrication of an atmospheric control subsystem for use on manned space vehicles.

$46,700—**Tempo Instruments, Inc.**, San Diego, for low-level ac in-flight telemetry calibration system.

$47,000—**Dynamic Devices, Inc.**, Dayton, Ohio, for a 1/40 scale dynamic replica model of the *Saturn V* launch vehicle.

$38,200—**Thiokol Chemical Corp.**, Elkton, Md., for nine "recruit" rocket motors.

$36,900—**Martin Co., Denver Div.**, Denver, Colo., for study of rescue and escape systems from tall structures for use at Launch Operations Center, Cocoa Beach, Fla.

$31,900—**Sangamo Electric Co.**, Springfield, Ill., for magnetic tape recorder-reproducer system.

$18,600—**Battelle Memorial Institute**, Columbus, Ohio, for fabrication of beryllium impact targets.

INDUSTRY

$820,000—**Schaevitz Engineering**, Pennsauken, N. J., from **General Dynamics/Pomona**, for production of accelerometers for use on a major missile program.

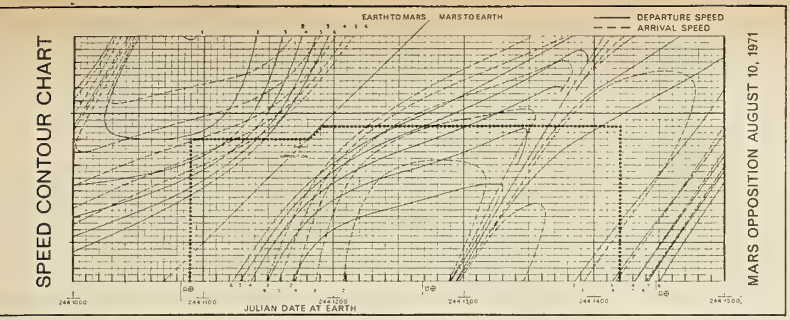
$442,000—**Beckman Instruments, Inc.**, Richmond, Calif., from **Hughes Aircraft Co.**, for two analog computers for use in the development of the *Surveyor* spacecraft.

$152,000—**Singer Co., Singer Metrics Div.**, Bridgeport, Conn., from **Sandia Corp.**, for acceleration sensing devices.

$100,000—**Garrett Corp., AiResearch Div.**, Los Angeles, from **McDonnell Aircraft Co.**, for development of a one-man environmental control system for use in *Gemini* paraglide trainers.

TRW's Space Technology Laboratories, Redondo Beach, Calif., from **Jet Propulsion Laboratory**, for development of a vernier engine for the *Surveyor* program (undisclosed amount).

TRW's Space Technology Laboratories, Redondo Beach, Calif., from **Grumman Aircraft Engineering Corp.**, for a development program for a lunar descent and landing engine for the LEM (undisclosed amount).



At Lockheed Missiles & Space Company, a dedicated team of scientists devotes ts entire attention to problems in interlanetary navigation. Of particular interest re problems attendant to the guidance f a manned vehicle to another planet. Vith many successful accomplishments o their credit (such as the Polaris and arious Agena missions), this group faces very new challenge with confidence.

A promising means for manned spaceraft guidance includes taking celestial nd planetary optical sightings, feeding hat information into an onboard comuter, and computing the spacecraft's osition and velocity to predict its future ourse. The computer will then calculate he predicted destination planet error, ecide if a correction is necessary, and compute its value. These procedures would be repeated continually until the planet is reached. The optimum timing and magnitude of correction, in view of the information obtained from the observations, is the subject of continuing study.

Even before work on hardware for an interplanetary mission is begun, orbit characteristics must be determined to set the requirements to be built into the spacecraft. An optimum trajectory must be shaped for the specific mission, in order to realize ultimate effectiveness. An outstanding accomplishment by Lockheed scientists is the computation of some 250,000 different orbits to Mars and a similar number to Venus. Each orbit varies as to speed, fuel, departure, arrival, and elapsed time.

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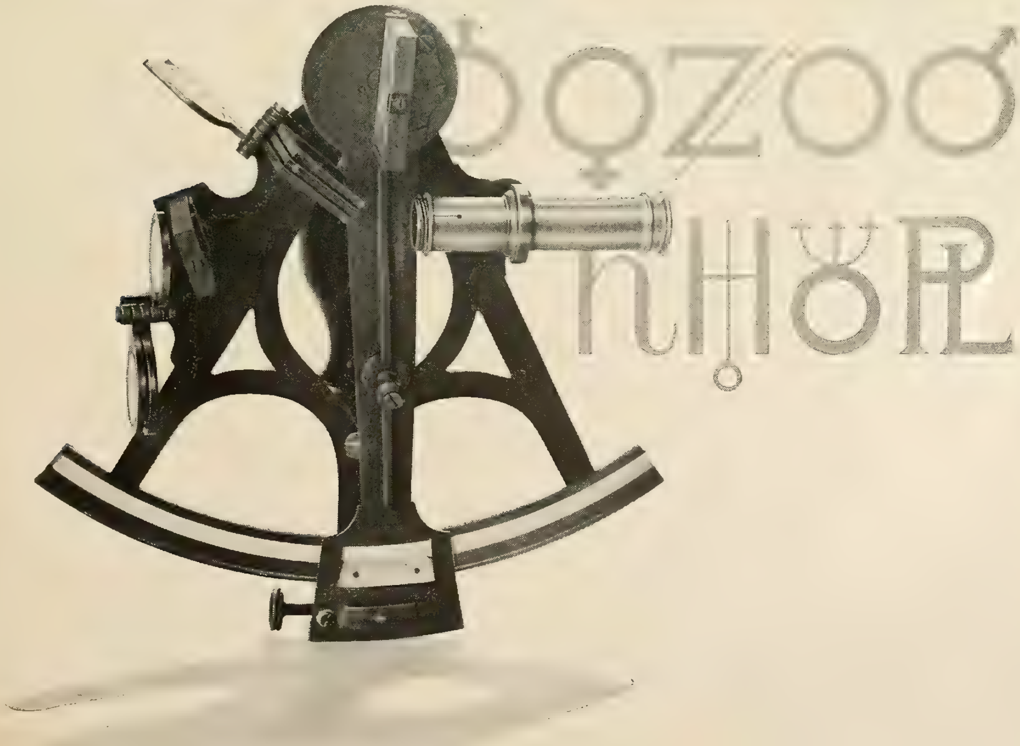

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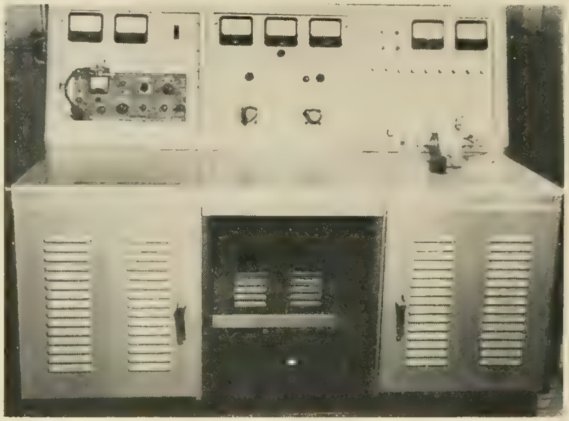
New Product of the Week:

Pulsed Back-Scatter Radars



Advanced Development Laboratories, Inc. has developed pulsed back scatter range radars. These units eliminate the need for cumbersome bucking circuits and are especially useful for targets whose intercept area greatly exceeds their back scattering area. Model No. 1084 operates between 14-18 Gc/s with a peak power of 1 kw. Selectable pulse lengths of 10 nanoseconds to 100 nanoseconds are provided along with variable repetition rates from 100 to 10,000 c/s. The receiver sensitivity is —80 dbm. Model 1084 uses a TWT final amplifier and can be readily adapted to provide coherent operation.

Model 1153 is an X-band unit operating at frequencies from 8.2 to 12.4 Gc/s. This unit has a minimum pulse width of 100 nanosec, a PRF of 24 Kc/s and peak power output of 0.5 watts. System sensitivity is —110 dbm

Circle No. 225 on Subscriber Service Card

L-Band Phase Shifter

Microwave Associates, Inc. is marketing an L-band continuous RF phase shifter capable of providing continuous, analog-type phase modulation by means of an applied bias voltage.

The MA-8352-2LIT phase shifter accomplishes this microwave control with use of varactor diodes, and therefore requires extremely low drive power —less than 0.01 watts—and has the capability of ultra-fast modulation rates. Sinusoidal modulation signals to 30 mc, or switching between two particular phase states in 10 nanoseconds is estimated.

This two-port transmission device has an RF cw power rating of 100 mw. Higher power levels can be achieved with slight phase shift versus power sensitivity. The instantaneous bandwidth is 800 mc to 1,400 mc, demonstrating 0 to 90° minimum phase shift with bias voltage change of 0 to 50 at less than 100 microamps.

Circle No. 226 on Subscriber Service Card

H-Parameter Test Unit

Full range 1,000 cps h-parameter tests on a go/no-go basis are now available in the new, automatic Model 657 h-parameter unit from the Industrial Products Group of Texas Instruments. When used with TI's basic Model 654 transistor and diode tester, small-signal tests can be made for h_{ib}, h_{ie}, h_{rb}, h_{ob}, h_{oe}, h_{fe}, h_{re}, and 1 h_{fb} plus dynamic impedance, Z_z, of zener diodes.

Test times from 1c of 125 milliamperes are programmed by plug-in printed circuit boards in the Model 654 equipment. Individual h-parameter tests are determined by plug-in logic boards in the 657 unit. A total of four boards can be used in any single test sequence with a total of eight limit settings in various combinations. To use all 15 test positions provided by the 654 equipment logic, two 657 units are used. Up to 1,800 devices can be tested per hour, depending on the number of small signal tests.

Circle No. 227 on Subscriber Service Card

Programming Switch

Requiring only 60% of the space normally used for more conventional switches, the Actan Division of Sealectro offers a 32-pole, double-throw contact arrangement programming switch offering as many as 16 programming drum positions.

The switch can be programmed in either of two ways: (1) Programming the drum in the usual manner will actuate each row of contacts, with a lag of 180°. Different programming functions can be achieved with the same program on the drum by changing wiring arrangements. (2) A stop to limit drum rotation to 180° can be provided for a second programming method. In this case, eight programs on the drum will actuate one row of contacts while a second set of eight programs on the drum will actuate the other contact row.

Circle No. 228 on Subscriber Service Card

Memory Core Handler

A low-cost, semi automatic Ramsey core handler which can sort 30, 50 or 80 mil memory cores under manual control or at speeds up to 1,800 cores per hour is available from Computer Test Co.

The device consists of a control unit, a vacuum pump, and an automatic feeder. In operation, cores are fed on edge from a vibrating bowl feeder down an enclosed chute. At the end of the chute, individual cores are held on a phenolic carrier by vacuum force and carried to a point where they are speared by a reciprocating two-conductor probe that completes separate drive and sense windings to the core. A solenoid, actuated by a sorting switch on the control unit, operates a sorting gate to direct the tested core to either an accept or reject core container. Two four-digit counters on the front panel of the control unit tally the total number of cores tested and the total number of rejects.

Circle No. 229 on Subscriber Service Card

Cryogenic Solenoid Valves

A line of two-way midget solenoid valves that operate at extremely low temperatures and high pressures has been introduced by the Automatic Switch. Co.

These units operate from —100°F to —400°F. Applications include controlling the flow of liquid oxygen and other fuels from storage and transport facilities to lightweight missile fuel tanks.

Designed to operate in the normally closed position, these solenoid valves are available in pipe sizes ⅛, ¼, and ⅜-in. for pressures to 1,100 psi. The valve body is constructed of brass or stainless steel with teflon and stainless steel discs and metal or soft seats.

Circle No. 230 on Subscriber Service Card

Pressure Transducer

Specifically developed for unusual industrial and aerospace applications requiring high output and accuracy, Micro Systems' Type PT4B-B2 and PT4F-B1 semiconductor pressure transducers offer users maximum reliability.

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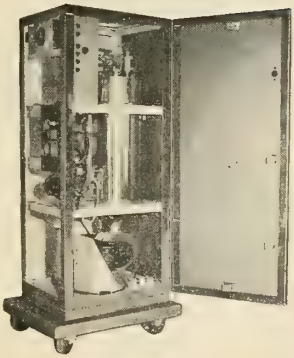
A LOW NOISE MICROWAVE AMPLIFICATION WITH MASERS



Model PA-1000
Maser Assembly

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- space probe tracking
- radio astronomy

If you are engaged in advanced space-age studies involving high sensitivity radar, space communications, low-noise radiometry or radio-astronomy, you are aware of the importance and increasing use of masers in microwave amplification.

Masers are used of necessity wherever low noise is a prime requirement.

Laser Systems Center, specializing in laser/maser R&D and manufacturing, now offers several varieties of masers for use in the X, XB, and KU bands. These include tunable cavity masers or complete maser radiometer packages (solid-state cavity, helium dewar, magnet, I-F amplifier, and detection and display equipment).

Typical signal characteristics (7 kmcs to 18 kmcs) using circulator input and open cycle refrigerant system: 70°K overall receiver noise temperature; 25°K to 35°K maser preamplifier noise temperature; 20 db to 23 db of preamplifier gain; 5 to 30 mcs bandwidth.

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names in the news

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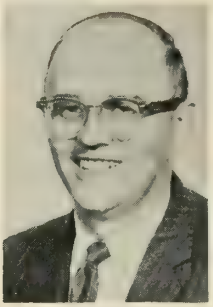
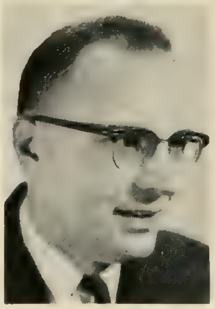
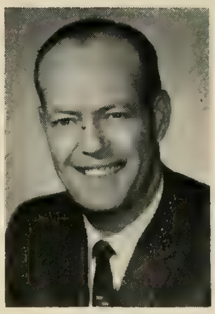

MEINERT


TEMPLE


DRISKILL

William J. Coughlin: Editor of MISSILES AND ROCKETS magazine was elected to a second term as president of the Aviation/Space Writers Assn. Also elected were **Claude Witze,** senior vice president of *Air Force/Space Digest* as first vice president; **Rick Kiefer,** KOB-TV, Albuquerque, second vice president; and **James Cahill,** editor of *Aviation News,* third vice president. **Leslie Spencer** was re-elected treasurer and **Ralph McClarren** returned as executive secretary.

Royce B. McKinley: Appointed vice president of finance and administration at Space-General Corp., El Monte, Calif.

J. A. Nava: Elected vice president in charge of engineering for Pyle-National Co., Chicago.

F. A. Ford: Named chief of advanced project, space engines, at Rocketdyne Div. of North American Aviation, Inc., Canoga Park, Calif.

Donald R. Humphreys: Appointed project manager in the engineering department of Antenna Systems, Inc., Manchester, N.H.

Glenn R. Lord: Named corporate vice president, marketing, at Northrop Corp., Beverly Hills, Calif., effective July 1.

Marlin G. Kroger: Named an assistant to the president of the Autonetics Div. of North American Aviation, Inc., Anaheim, Calif.

Herman Pusin: Named general manager of research and engineer operations for the Martin Co., Baltimore, Md. **Jeremie U. LaFrance** named director of engineering, and **Walter D. Smith** appointed technical director of the *Titan II-Gemini* program.

Roger West: Appointed instrument sales manager for Halex, Inc., El Segundo, Calif.

Robert R. Meinert: Appointed manager of government sales for the Whitney Blake Co. and Loiled Kords, Inc., a subsidiary, New Haven, Conn.

D. James Martin: Promoted to regional sales manager for the northwest regional office of Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp., Palo Alto Calif.

Richard H. Holmberg: Joined Lockheed Missiles and Space Co., Sunnyvale Calif., as manager of TRACE engineering.

David A. Anderton: Has opened an independent technical consulting service after resigning from *Aviation Week* magazine, New York City.

Russell A. Temple: Joined the staff of Electro-Optical Systems, Inc., Pasadena, Calif., as manager of optical design and fabrication.

Roger D. Driskill: Appointed manager-engineering of the Electronics Div. of Research-Cottrell, Inc., Bound Brook, N.J.

Dr. Leonard C. Maier, Jr.: Named general manager of General Electric Co.'s Semiconductor Products Dept., Syracuse, N.Y.

Nicholas M. Voorhies: Appointed general manager of Martin Co. activities in Washington, D.C.

Gordon Henning: Appointed manager-market planning for Avco Corp.'s Electronics Div., Cincinnati.

Dr. A. Richards Marks: Appointed director of Space Technology Laboratories' planning, research and analysis staff, Redondo Beach, Calif.

Paul G. Gill: Appointed vice president and director of economic research at Technology Markets, Inc., New York City.

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—when and where

JUNE

American Society for Quality Control Reliability Training Conference, The Bishop's Lodge, Santa Fe, N.M., June 10-14.

Symposium on Plasma Space Science, supported by NASA and Goddard Space Flight Center, Catholic University of America, Washington, D.C., June 11-14.

AIAA Heat Transfer and Fluid Mechanics Institute, California Institute of Technology, Pasadena, Calif., June 12-14.

American Society for Testing Materials Annual Meeting, Purdue University, Lafayette, Ind., June 13-18.

Instrument Society of America National Biomedical Sciences Instrumentation Symposium, Sheraton-West Hotel, Los Angeles, June 14-17.

AIAA Summer Meeting, Ambassador Hotel, Los Angeles, June 17-20.

Institute of Electrical and Electronics Engineers, Summer General Meeting, Toronto, Canada, June 17-21.

American Nuclear Society Annual Meeting, Gatlinburg, Tenn., June 20-24.

American Institute of Electrical Engineers Summer General Meeting, Fountainebleau Hotel, Miami Beach, Fla., June 20-25.

Institute of Space Communications, sponsored by the University of Maryland with the cooperation of the Goddard Space Flight Center, University of Maryland, College Park, Md., June 23-28.

66th Annual Meeting, American Society for Testing and Materials, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., June 23-28.

Symposium on the Problems and Application of Dielectrics in Space, Westinghouse Research Laboratories, Pittsburgh, June 25-26.

AIAA First Annual Meeting and Exposition, Sheraton-Park Hotel, Washington, D.C., June 29-July 3.

JULY

IEEE 1963 International Symposium on Space Telecommunications, sponsored by Professional Technical Group—On Antennas and Propagation, Boulder Laboratories, National Bureau of Standards, Boulder, Colo., July 9-11.

Meteorological Support for Aerospace Testing and Operation, sponsored by AIAA and American Meteorological Society, Ft. Collins, Colo., July 10-12.

National Association of Power Engineers National Convention, Everglades Hotel, Miami, July 14-19.

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Mass., Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News*, University of Colorado, Boulder, Colo., Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference, sponsored by NBS Cryogenic Engineering Laboratory and University of Colorado, Boulder, Colo., Aug. 19-21.

Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

AIAA Simulation for Aerospace Flight Conference, Deshler-Hilton Hotel, Columbus, Ohio, Aug. 26-28.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Mass., Aug. 26-28.

American Institute of Electrical Engineers Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

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Further on Ethics

WE PRESENT herewith a poem for astronauts which we composed after consideration of the fact that the nine new astronauts are to join the seven senior astronauts in a $3.2-million contract for exclusive rights to their personal stories. We call it the 32nd Palm.

Here we go, up and around
We'll all be rich when we get on the ground
Camps for boys, apartments for rent
Invest in motels, count every cent
Don't write it for *Look*, write it for *Life*
They'll even pay to talk to your wife
We make money up in the sky
The ante goes up every time that we fly
Have no fear, new astronauts, all is serene
The *Mercury* capsule was a money machine
And there's more to be made, some of it soon
When we write it for Field on the way to the Moon
So take advice from us seven
And all your bills will be paid
Just sign up with Leo and Harry
And we've all got it made.

The above was inspired by the fact that Mr. Leo DeOrsey, business manager for the original astronauts, decided last week to parade his nauseating money-making policies for the astronauts in a piece for a Sunday supplement. Its title: "Let's Stop Picking on the Astronauts."

This sickening recital of the trials and tribulations of what Mr. DeOrsey calls "my boys" does them no favor. The attorney attempts to defend his recommendation that the astronauts accept the free homes offered in Houston on the grounds that "no commercialism was involved." He drags in the war records of the astronauts, which certainly no one has ever questioned, with the comment, "I have no need to apologize for my boys' war records."

Mr. DeOrsey says of the astronauts: "They are human beings, too, who want to live like the family next door. Privacy, I would remind you, is a precious human right."

Privacy and living like the family next door, we would remind him, are things the astronauts knew they would have to give up when they signed on for the job. To plead privacy and at the same time to attempt to defend a $500,000 sale of personal stories which have spread exclusive material on wives and families through the pages of *Life* magazine is hardly consistent.

Regarding the barring of newsmen and photographers from the homes of the astronauts during the flights, Mr. DeOrsey has this to say concerning one of the wives: "I felt she had a right to be alone in her home with her children and those of her choosing on such an awesome occasion."

We certainly would agree, but Mr. DeOrsey neglects to point out that the chosen few may, of course, include a *Life* photographer and reporter. It seems that privacy, that precious human right, can ethically be violated by the highest bidder.

The attorney goes through a tear-jerking list of financial deals which he and the astronauts turned down for one reason or another, including the noble rejection of *National Geographic's* offer of $2,500 for its use of excerpts from the flight transcript.

Mr. DeOrsey neglects to comment on a number of controversial and much-discussed aspects of the business dealings of the astronauts. There is no mention of the unsavory motel situation at Cape Canaveral, of the apartment building outside Washington, of the boys' camp in the Carribean which *Newsweek* reported could capitalize on the lure of the astronauts, of the reported squabble between new and old astronauts concerning the new contract for personal stories, or of the *New York Times* report that Robert DeOrsey, son of Leo DeOrsey, was agent for $100,000 in life insurance policies issued to each of the *Mercury* astronauts by Aetna Life Insurance Co.

The failure to comment on the latter is interesting, since Mr. DeOrsey does point out that one insurance company had written him to say it had been "chosen" to write insurance on the astronauts, with the premiums to be paid by patriotic Americans.

"Chosen by whom?" he asks scornfully. "The advertising department?"

Mr. DeOrsey obviously operates on a very strange code of ethics.

WE ALSO FIND it disappointing that the White House, which initially indicated it would not permit any repetition of the *Life* contract arrangement, now has reversed itself after a special plea by the astronauts.

According to the *New York Times*, NASA gave its sanction to the practice with some misgivings and only under White House orders.

This is now leading to a $3.2-million contract with Field Enterprises, publisher of the *World Book Encyclopedia*, for exclusive rights to personal stories of all 16 astronauts. We do not think any exclusive contract is in the national interest—and we say this without prejudice because the stories are not of a type we would print.

A NASA official has commented on the contract as originally written: "We began to wonder when they would find time to work for us."

The document is being revised over the objections of Philadelphia advertising man Harry A. Batten, who represents the new astronauts. Mr. Batten says NASA is "so anxious to spell out every detail in the contract that it began to look like these guys would be simply movie actors."

To that we might comment that if they are going to act like movie actors and display the ethics of movie actors, they deserve to be treated like movie actors. They are all great guys. But they are listening to bad advice.

William J. Coughlin

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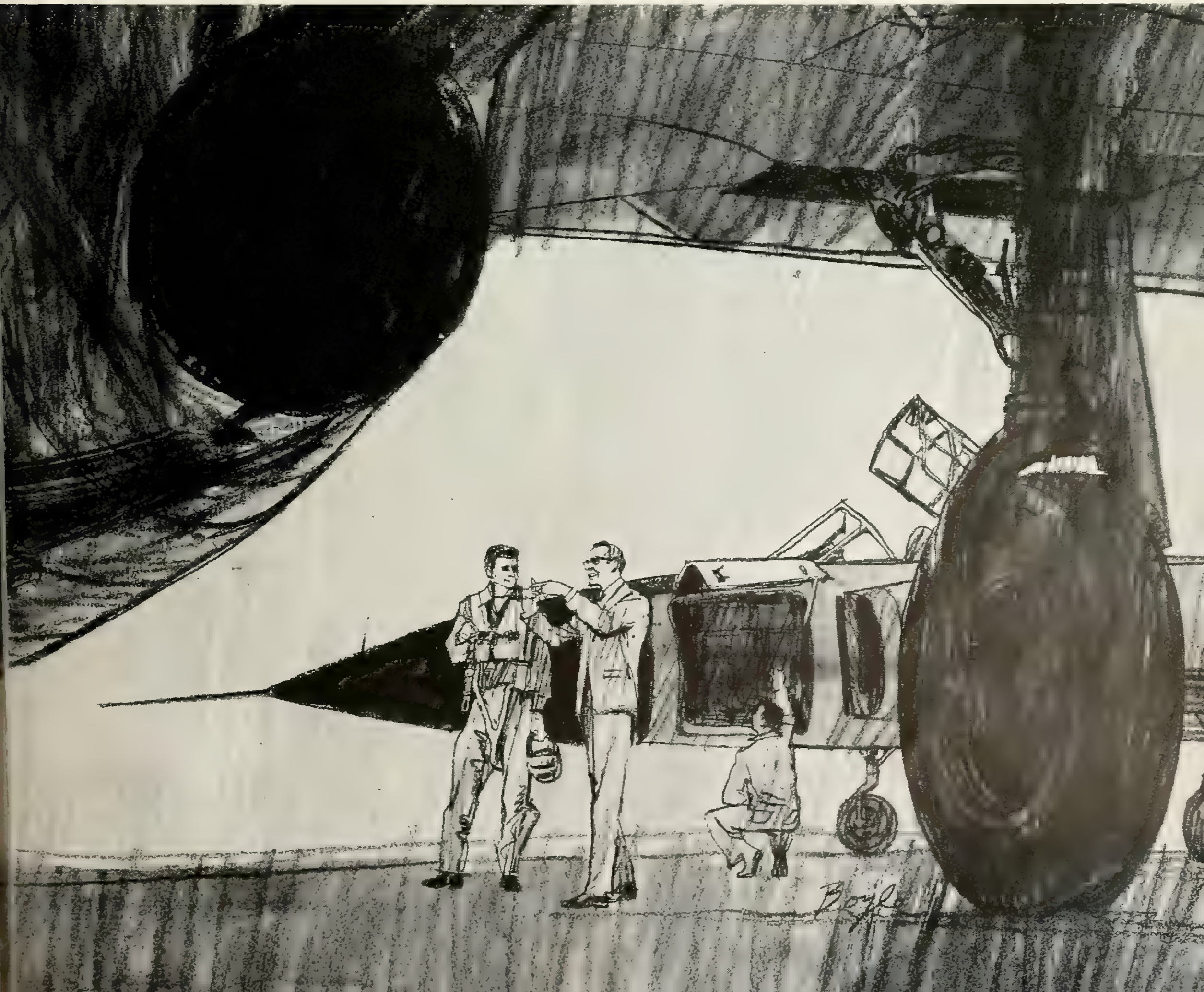

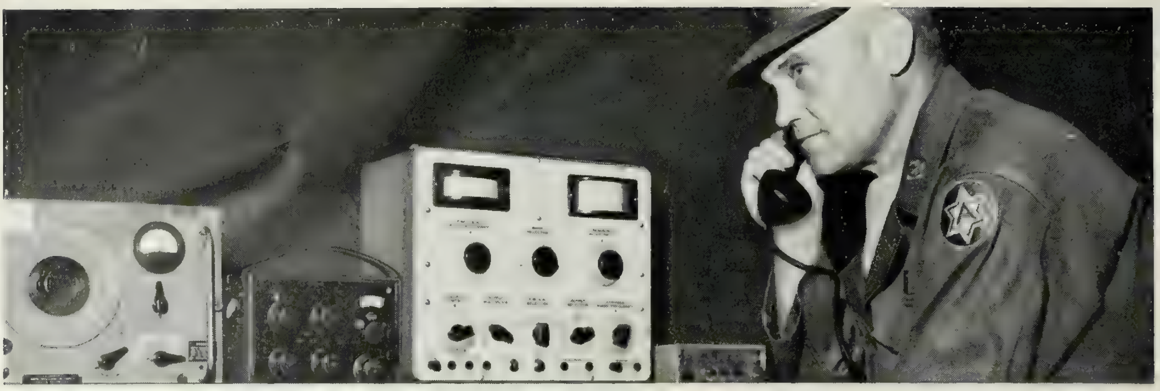

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JUN 1963

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Titan II Now Operational

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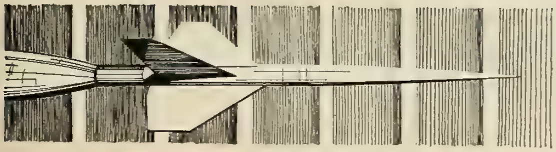

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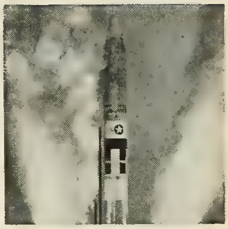

Air Force Titan II ICBM roars from silo at Vandenberg AFB, Calif., (see p. 10) on way to target area in the South Pacific. Man-rated version of Martin-built missile will boost NASA's two-man Gemini capsule on manned flights set to begin late next year.

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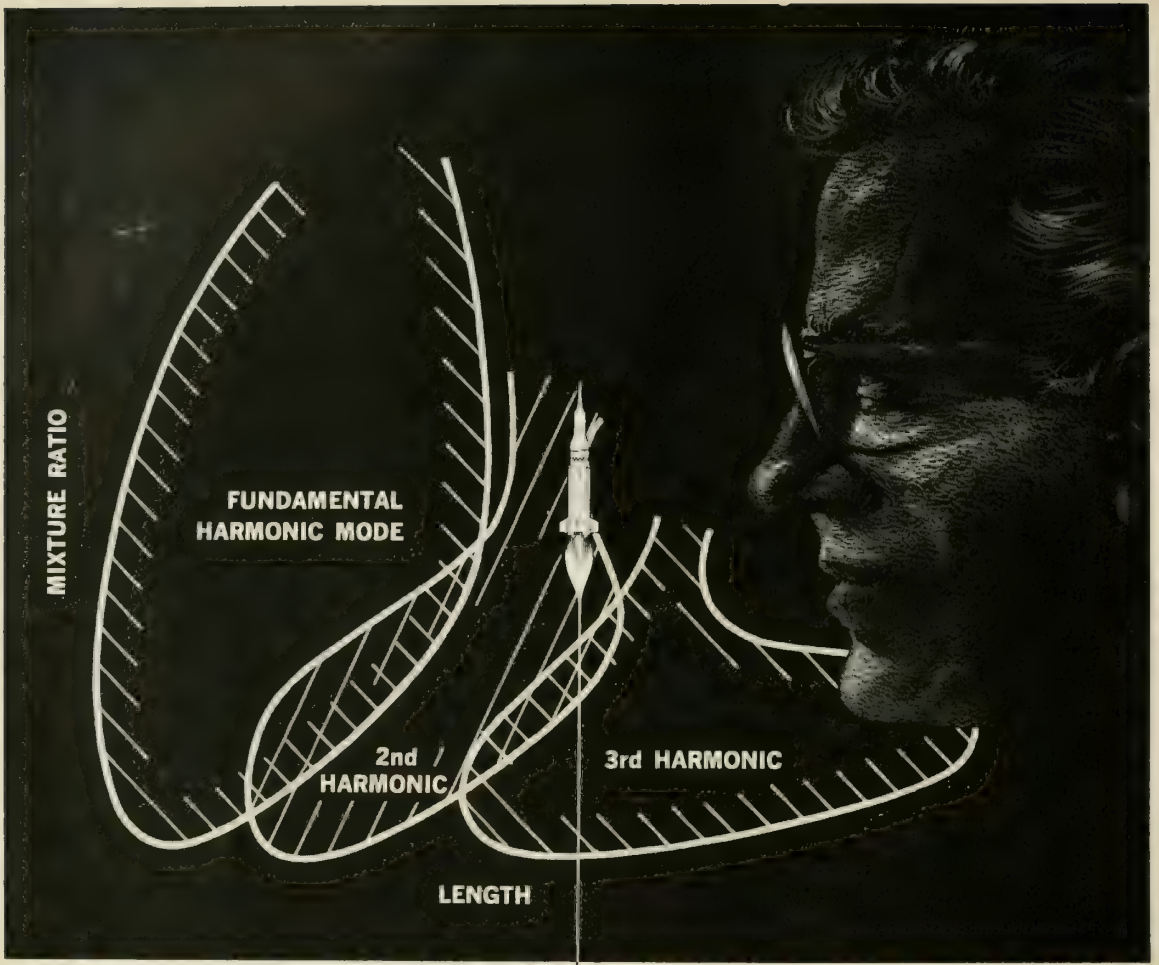

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The Moon Program 'Stunt'

To the Editor:

In his letter on the *Apollo* project (M/R, May 27), K. G. Hagen gives only two purposes for the manned Moon landing program—a scientific venture and a publicity stunt. His choice of words and their implications and connotations shy away from the primary reason for urgency in our space program. The real basis for the almost unanimous support by Congress last year and the expected majority support this year is not even mentioned. That is, of course, competition with Russia. As explained in many places by many people, including my article on the Panama Theory (M/R, May 29, 1961, p. 86), and your editorial in the same issue, we cannot allow Russia to gain either a position or a technological advantage in space.

Arthur C. Clarke emphasized the strategic importance of the Moon in *Harper's Magazine*, December, 1961, as follows:

". . . I wonder if any of the 'Leave-it-to-the-Russians' school of anti-spaceflight critics seriously imagines that Soviet science is outward-bound merely to impress the uncommitted nations. That could be achieved in a dozen less expensive ways. No, the Russians know exactly what they are doing. Perhaps they are already laughing at the shortsighted prophets who have said: 'Anyone who owns the Moon can dominate the Earth.' They may no longer be concerned with such trivialities. They realize that if any nation has mastery of the Moon, it will dominate not merely the Earth, but the whole accessible Universe.

"If, in November, 1967, there are only Russians on the Moon to drink a toast to the fiftieth anniversary of the Revolution, they will have won the solar system, and theirs will be the voice of the future.

"As it will deserve to be."

While I cannot agree that achievement of the first landing will necessarily give Russia control of the Moon, it will certainly indicate a lead in the race for control.

But, entirely apart from these other reasons for the Moon race, consider the first reason chosen by Mr. Hagen—the publicity stunt. According to Webster, a stunt is "a feat of skill, strength, or the like, especially one done to attract attention."

"Publicity stunt," then, doubly emphasizes the attention-attracting aspect, and critics of the space program use this term as a derogatory description of its purpose because of the connotation of fraudulence and cynical self-aggrandizement. It is common knowledge that publicity stunts are staged to attract attention to individuals or products and thereby to increase the apparent value or importance of the person or product *without regard to the true value.* However, the mere attempt to attract public attention need not carry this connotation and the product advertised may be of very great value, indeed. Products of high intrinsic value, unfortunately, do not always sell themselves.

If the man-in-space program is a "publicity stunt," by the same token the death of Socrates could also be given this name. He was trying to attract public attention to the importance of civil law. Doolittle's raid on Tokyo was primarily a "publicity stunt," since its direct military effectiveness was negligible.

Sometimes, products of the highest value need spectacular advertising before they can be sold, and the extremes to which the advertiser may feel impelled to go should not be used as a negative any more than a positive measure of the value of his product.

The military and technological strength of the U.S. were real enough, but Doolittle's raid helped to sell them. The desire for freedom of our founding fathers was real, but the Declaration of Independence helped to sell it. And before we criticize the *Apollo* program as just a "publicity stunt," we might consider the spectacular attention-getting devices which helped to found Christianity.

While advertising of our technological, economic, and military strength may not be the most important reason for the Moon program—I don't believe it is—efforts to enhance the prestige of the United States should not be equated with the "attention-for-attention's-sake" antics of some of our public figures whose fame may exceed their intrinsic value.

In short, the term "publicity stunt" would not even be a fair label for the conquest of Mt. Everest, Lindbergh's flight across the Atlantic, or Columbus' voyage to America, and would not be used by anyone trying to present an objective evaluation of the *Apollo* program.

D. M. Cole
Bryn Athyn, Pa.

Misplaced Conference

To the Editor:

I found your story, "Contracting System Scored" (M/R, June 3, p. 10) very interesting, since the NASA contracting system does represent a real problem to both the contractors and, I think, NASA. Both Kenneth Kelleher and Robert Tucker said things that have needed saying for some time, and you have given their statements well-deserved publication.

There is one small criticism, though: the conference was held in New Orleans, not Washington! I'm sure this was an inadvertent oversight on your part.

I am still a booster of the splendid accurate reporting of MISSILES AND ROCKETS. However, many of our NASA friends attending the New Orleans conference were surprised to read that you had made a slip of the pen.

James E. Fitzsimmons
Manager of Development
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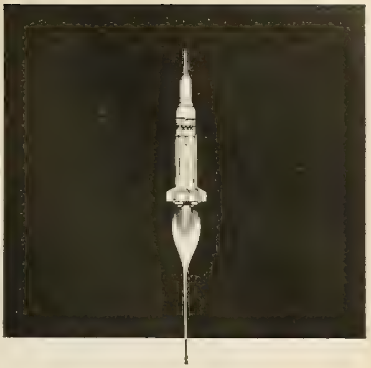

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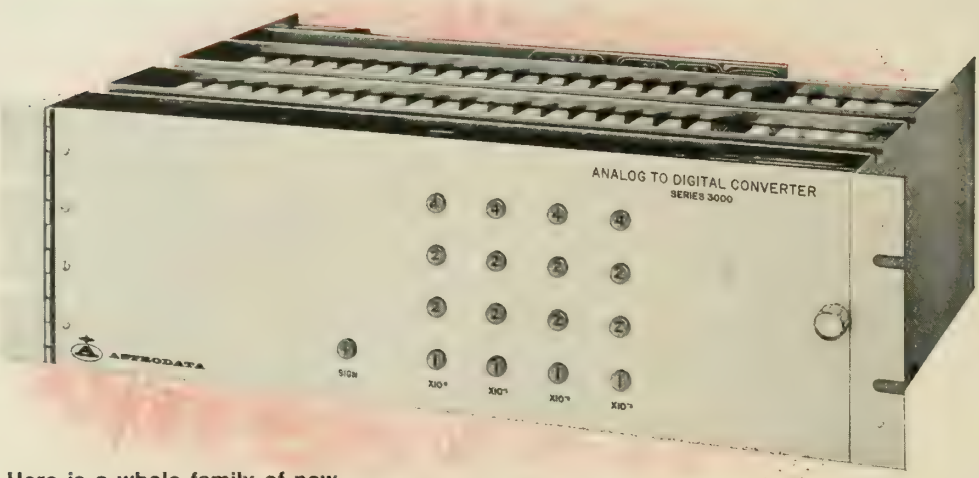

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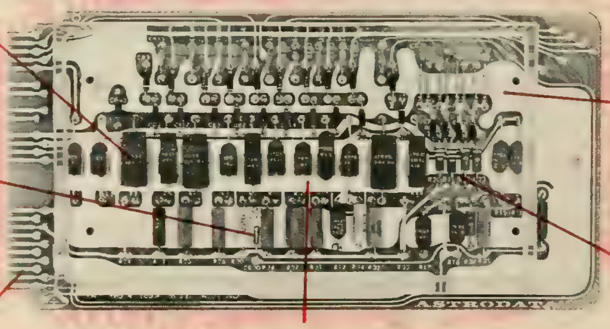

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The Countdown

WASHINGTON

Further Trouble Ahead for Apollo

Top-level management eruption in NASA's manned spaceflight program last week may be only the first of a series of similar difficulties. Further resignations are expected.

NASA To Buy Sixth Gemini Test Capsule

NASA is negotiating with McDonnell Aircraft for the purchase of a sixth *Gemini* static-test vehicle. Current program calls only for five. McDonnell also has received a $20-million payment on its *Gemini* prime contract—bringing the total received so far to $215 million.

MIDAS Program Funds Cut By 50%

Dept. of Defense has cut funding of the re-oriented *MIDAS* early-warning satellite program from $150 million in Fiscal '63 to $100 million in the FY '64 budget. Total allocated to date: $450 million.

NAA To Study Six-Man Apollo Ferry

NASA has awarded North American Aviation a $100,000 contract to study a six-man *Apollo* spacecraft which would be used as a ferry vehicle to a *Manned Orbiting Space Station*. The firm also recently received a $60-million payment for its work on the *Apollo* Command and Service Modules.

Manned Space Flight Cut: $257 Million

Cuts of $257 million in the manned spaceflight program will be recommended to the House Space Committee by its subcommittees. With other recommendations, this means the space committee will be considering cuts of $400 million in the NASA budget. Recommended cuts in the *Apollo* budget amounted to a 9-10% reduction in funding. *Gemini* escaped the knife. Insiders expected the full committee to approve the full $400-million reduction this week.

NASA To Study Titan II Vibrations

NASA later this year will conduct studies with human subjects to determine if the current vertical vibration rate of 11 cycles per second of the *Titan II* launch vehicle will prevent *Gemini* astronauts from reading instruments during launch. Martin Co. reports it now has 95% of the so-called "pogo" problem licked. The company says the problem will be completely solved by the time it concludes 35 test flights of *Titan II*—just prior to manned *Gemini* launches. Mating of the first man-rated *Titan II* was accomplished recently by Martin and the vehicle is scheduled for shipment to Cape Canaveral around July 1.

ARMY To Order French Missiles

U.S. Army is about to sign a contract with France's Nord Aviation for a large number of *ENTAC* and *SS-11* antitank missiles. Anticipated buy of *ENTAC's* is expected to be about 8,000.

Dyna-Soar Emphasis Now is Suborbital

Dyna-Soar program now before Secretary of Defense McNamara for approval places emphasis on test of *X-20* re-entry vehicles and aerodynamic measurements in suborbital flight—a switch in emphasis from earlier orbital planning. Program calls for "possible" orbital shots later.

Mars Trips Expected in Convoy

Project Empire, NASA study being conducted by Martin Co. and General Dynamics/Astronautics, suggests that manned trips to Mars are likely to be made in convoys of spacecraft. A typical convoy might be composed of four spacecraft, of which two would be unmanned supply and equipment carriers. It would take six months to assemble such a convoy in Earth orbit, despite very high launch rates and *Nova* boosters with million-pound payloads.

How About Naming It Fundless 7?

End of Project *Mercury* with the decision against an *MA-10* flight finds three *Mercury* spacecraft at Cape Canaveral. Two are in preliminary status, but one—spacecraft 15B—already was being modified for the *MA-10*.

INDUSTRY

NASA Seeks Advanced Pressure System

Proposals for development of an advanced pressurization system for manned space vehicles using cryogenic propellants are due at the Lewis Research Center by July 8. NASA has invited 53 firms to submit proposals.

Patent Granted for Mercury Spacecraft

A patent on the *Mercury* spacecraft has been issued to seven project officers at the *Mercury* Manned Spacecraft Center. Patent was issued on June 11 to Maxine A. Faget, Andre G. Mejer, Jr., Robert G. Chilton, Willard S. Blanchard, Jr., A. B. Kehlet, Jerome B. Hammack and Caldwell C. Johnson, Jr.

GCA Study Confirms Sporadic-E Theory

Geophysics Corp. of America scientists, in conjunction with NASA's Goddard Space Flight Center, have confirmed the theory that "Sporadic-E" radio communications disturbances are associated with certain upper-atmosphere wind shear conditions. Wind shears are zero-velocity belts sandwiched between two high-velocity streams moving in opposite directions. Effect of this action on Earth's magnetic field creates the relatively thin and sometimes 50-mile-long Sporadic-E layers, which are most pronounced at a 100-km. altitude.

Florida Softens Off-Shore Decision

The state of Florida has partially reversed an earlier decision and agreed to consult NASA and Dept. of Defense before allowing any use of offshore waters in the area between Daytona Beach and Sebastian Inlet, some 100 miles to the south. A request by the two agencies for complete control of the waters was turned down two weeks ago, but a reconsideration resulted in an agreement to issue no permits, leases or grants without approval of NASA or DOD.

INTERNATIONAL

French Firms Sign Cooperative Pacts

Nord Aviation and SNECMA have signed an agreement to work together on the research and development of ballistic missiles and space boosters. Sud Aviation and SEPR are said to have signed a similar agreement in anticipation of the Nord-SNECMA pact.

The Missile/Space Week

Mercury Gone, Holmes Going

D. Brainerd Holmes, Director of NASA's Office of Manned Space Flight, is resigning his position following a long disagreement with top space agency and Kennedy Administration officials over funding for the *Gemini* and *Apollo* programs.

The resignation was not attributed to NASA's decision against another *Mercury* flight, a decision Holmes supported.

Holmes will leave the space agency by September, although he has not yet secured another position with industry.

Confusion over the resignation came when the announcement was made by NASA after the agency disclosed that it had decided against another manned space flight in the *Mercury* series. NASA said termination of the program would permit Holmes to return to private industry "within the two-year period" he set when he accepted the job of directing the manned lunar-landing effort.

- **Money the root**—Reliable sources reported, however, that the problem was money. The disagreement began in December, 1962, when NASA Administrator James E. Webb and the Kennedy Administration decided not to seek a $400-million supplementary Fiscal 1963 appropriation. The decision—opposed by Holmes and officials of the Office of Manned Space Flight and the Manned Spacecraft Center—resulted in a four-to-six-month slippage in the *Gemini* two-man spaceflight program.

The disagreement continued during formulation of the space agency's Fiscal '64 budget request of $5.7 billion. Holmes wanted a budget of $6.2 billion. When the lower figure was announced, officials admitted it would push the target date for the first manned lunar landing back six months—from 1967 into 1968.

Further slippage seems likely for two reasons. The House Space Committee is moving toward a $400-million reduction in the next fiscal year's authorization and the Kennedy Administration is making no attempt to fight it.

Also, Webb has already indicated that the Fiscal '65 budget for the civilian space program may even be lower than the Fiscal '64 request.

- **Agreement on MA-10**—The sources added that the *Apollo* program is slipping and likely to slip again in the future. Holmes was willing to do the job, they said, as long as he was getting the funds to do it successfully in line with President Kennedy's declaration of the national goal—a U.S. manned lunar landing before the end of this decade.

Queried by MISSILES AND ROCKETS, Holmes said that he had told NASA officials when he accepted the job in 1961 that he might leave in a two-year period. He also denied that he was resigning because of disagreement over the decision to drop plans for an *MA-10* flight. "I'm in complete agreement with Mr. Webb on that one," Holmes said.

The NASA announcement of the Holmes resignation said Associate Administrator Robert C. Seamans, Jr., would devote a large share of his time to the *Gemini* and *Apollo* programs and to properly relating these to all other NASA programs. This would be possible, the space agency said, because the job of Deputy Associate Administrator—vacant since the resignation of Thomas F. Dixon—would be filled in two weeks. The deputy associate administrator will direct NASA activities in the offices of Space Sciences, Applications and Advanced Research and Technology.

No mention was made of Holmes' successor—or even whether there would be one.

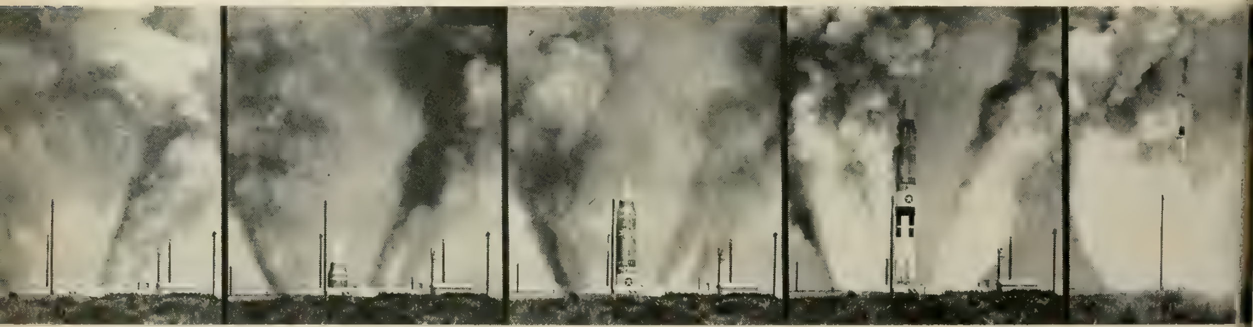
The announcement also said that the loss of Holmes might force a reorganization of the space agency.

"In the realignment of the manned space flight programs," it said, "the Office of Manned Space Flight and the three NASA centers working on the program might also have to be realigned." There was no further explanation of what type of realignment or reorganization was being considered.

STL Gets Pioneer Contract

NASA has selected Space Technology Laboratories, Inc., to design and fabricate the *Pioneer* interplanetary solar probe.

The total value of the incentive contract—calling for four probes—is expected to be approximately $15 million. NASA plans, however, call



Silo-Launched Titan II ICBM Begins 5,000-mile Flight

An Air Force Titan II is shown as it rises from an underground launch site at Vandenberg AFB, Calif. during a recent test firing. First operational squadron of nine Titan II's was formally turned over to the 570th Strategic Missile Squadron at Davis-Monthan AFB, Ariz., by the Martin Co. June 13. Ground breaking on the missiles' bomb-proof launchers was in December, 1960. A secon Strategic Air Command Titan II squadron is scheduled for activation soon at Davis-Monthan. The two-stage, 115-ft.-tall missil is fueled with storable nitrogen tetroxide and Aerozine-50 an its range is more than 5,000 miles.

for launching seven *Pioneers.*

First launch of the 100-lb. satellite is scheduled for early 1965 aboard a *Delta* vehicle from Cape Canaveral.

Pioneer will carry a payload of 20-lbs., will be cylindrical in shape and covered with some 10,000 solar cells. It will have four outriggers, or booms, for spin stabilization.

Five experiments, varying from mission to mission, will be held in the payload, including magnetometers, radio propagating plasma spectrometers, solar particle species, high-energy particles, ionization- and medium-energy particles.

The spacecraft will be injected into solar orbit with variable ellipses for different missions. Orbits will range from eight-tenths of an astronomical unit to 1.2 AU's. Its nominal lifetime will be six months, with a communication capability of 60-90 million miles. NASA is currently negotiating an incentive contract with STL, estimated to be about $15 million.

NASA Grants Patents to Two

NASA has granted commercial rights on three patents to two firms that developed the inventions under space agency contracts.

Commercial rights on two inventions were awarded to Ampex Corp. and, on one invention, to Space Technology Laboratories, Inc.

The new grants bring to 46 the number of waivers granted by NASA.

Ampex was granted patent rights for an electronic chassis—an arrangement of printed circuit boards with effective dissipation of heat—and for a tape transport—an apparatus for processing magnetic recording tape.

The STL waiver covered a multiphase electric system—a three-phase ring-counter circuit for supplying multi-phase current.

The waivers may be voided after five years if the recipients do not show that the inventions have been developed to the point of practical application or have not been made available for license to others. The government retains a license for governmental use of the inventions.

Centrifuge Designer Picked

Trio-Tech, Inc., Glendale, Calif., has been selected by NASA to design and manufacture a unique centrifuge at Langley Research Center. The unit will be used in preflight testing of

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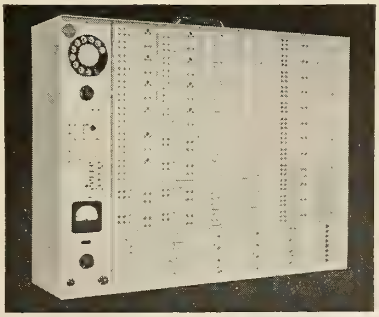

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Trio-Tech will also design two separate control systems to vary the speed of the rocket motor from 0 to 3,000 rpm and the other to control the speed of the centrifuge arm from 0 to 470 rpm.

Shots of the Week

President Sarvepalli Radhakrishnan of India viewed successful firings of the *Minuteman* and *Polaris* at Cape Canaveral June 5-6. The silo-launched Wing II *Minuteman* carried a Mark II Avco nose cone 5,000 miles down the Atlantic Missile Range to a point near Ascension Island June 5.

Countdown and launch were performed by the 6555th Aerospace Test Wing of the Air Force Missile Test Center. The following day a *Polaris A3* scored a success from a flat land pad at the Cape.

Other shots of the week:

- An Air Force *Atlas E* ICBM, launched from Vandenberg AFB, Calif., June 4, successfully flew 4,000 miles down the Pacific Missile Range. Primary test objectives were evaluation of the airborne vehicle and associated Aerospace Ground Equipment. Launch was conducted by Air Force and contractor personnel.
- A second firing of the 82-ft. *Atlas* came off routinely from Vandenberg June 12.
- A June 12 *Mace* training shot by a crew being graduated from the Air Force Tactical Training School at Orlando, Fla., was successful.

Goodrich To Build Big Cases

Two full-scale 156-in., three-segment filament-wound rocket motor cases will be fabricated by B.F. Goodrich Aerospace and Defense Products under a contract from Thiokol Chemical Corp.

Thiokol won the award from the Manufacturing Technology Div. of the Air Force's Aeronautical Systems Command, while Aerojet-General was picked to fabricate monolithic 260-in. glass-wound cases.

The 50 ft. long Goodrich cases, will be evaluated by Thiokol's Wasatch Div. at the end of the 15-month fabrication program. The Thiokol award and the subsequent subcontract to Goodrich has stirred the industry since the Air Force program is ostensibly a push to develop manufacturing techniques.

Goodrich is already an established winder while Thiokol has a minimum amount of equipment. In addition, the whole program of funding such an approach is openly questioned by industry since the ability to wind such large structures has been demonstrated in at least two distinct cases.

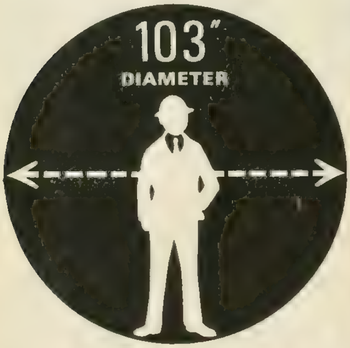
Mars Trip Decision Urgent

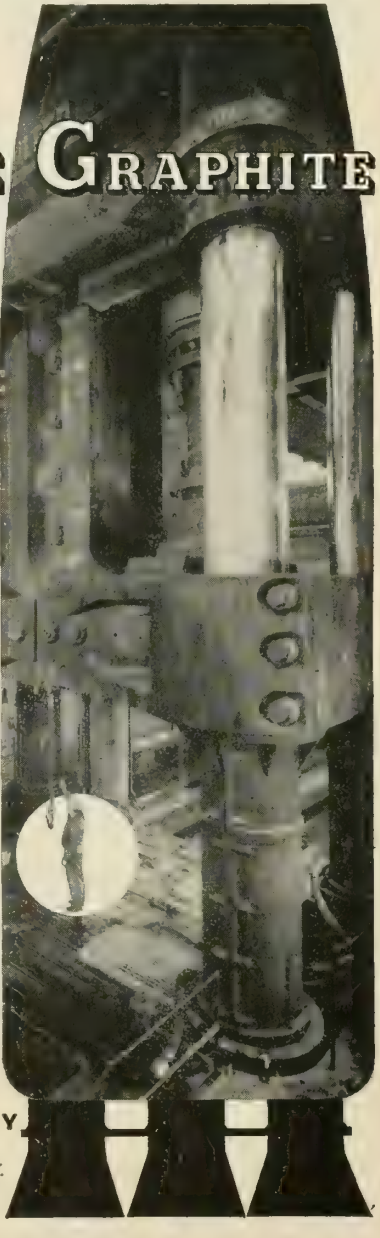
An early decision on when the U.S. will attempt the manned exploration of Mars is a pressing necessity. This was the consensus at the Mars Exploration Symposium of the American Astronautical Society in Denver.

The highly elliptical orbit of the planet puts the next best mission opportunities in about 1975 and 1983.

Two critical development areas for a full-scale Mars program appear to be propulsion and life-support systems.

Harold B. Finger, manager of the joint NASA/AEC Space Nuclear Propulsion Office, would abandon the first Mars opportunity, at least for manned landings, and concentrate on preparing for landings in the 1980's.





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He contends that advocates of an early mission underestimate the difficulty of developing engines equal to the job.

Opposing Finger's view was Maxwell Hunter of the President's National Aeronautics and Space Council. He said Finger is guilty of the familiar error of underestimating the future advance of technology.

Hunter proposes an attempt at the early Mars opportunity, with full-scale development of large recoverable launch systems able to do the job efficiently. He opposes extension of *Apollo*-generation hardware to the new mission. One argument against that idea is the large number of launches required with *Saturn*-series boosters.

"We need a transportation system," Hunter said. "This idea of using many rockets is something left over from the ammunition business."

Nine Bidding for LRM

Nine firms have submitted bids on each of two NASA studies of a possible Lunar Reconnaissance Module (LRM) for the *Apollo* spacecraft.

The six-month studies—budgeted at $198,000—are designed to provide a system that would permit *Apollo* astronauts to make their own landing site surveys.

The studies call for two separate approaches to the problem. One possibility would be to put photographic, infrared and radar-mapping equipment on the command module of *Apollo* or in a special LRM. The other calls for launching 10 or more reconnaissance probes from orbiting *Apollo* spacecraft, each capable of transmitting similar data as well as testing the load-bearing ability of the Moon's crust.

Firms bidding on the LRM study are: Bendix Radio Div., Fairchild Space Div. Systems, Ford Aeronutronic, General Dynamics/Fort Worth, North American Space and Information Systems, RCA-Defense Electronics Div., Boeing Co., Conductron Corp., and Hycon Manufacturing Co.

Companies competing for the lunar probe study are: Bendix Systems Div., Fairchild Stratos, Ford Aeronutronic, General Dynamics/Fort Worth, Missiles-Rockets-Moon Systems, North American Space Information Systems, RCA Defense Electronics Div., Space General Corp., United Aircraft Corp. Systems Div., and Hughes Aircraft Systems Div.

The contracts are expected to be awarded in a few weeks.

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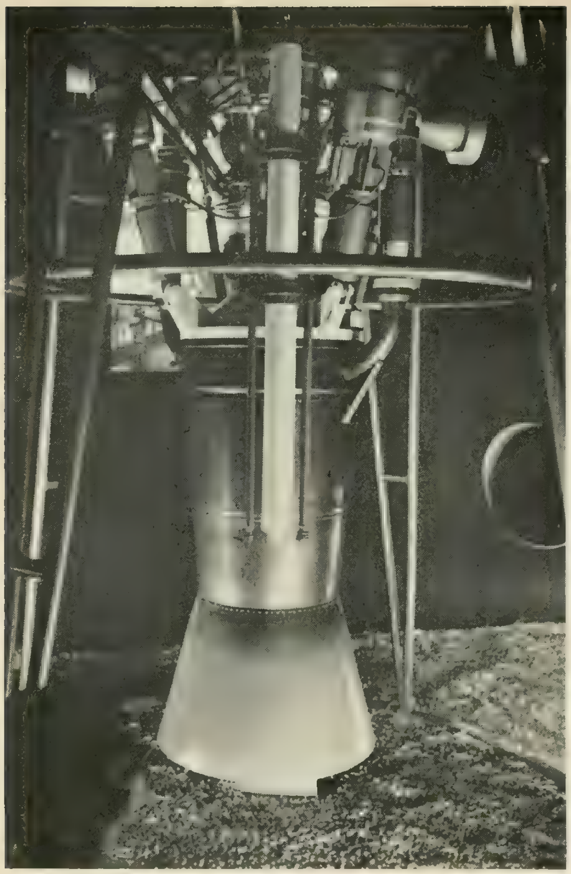
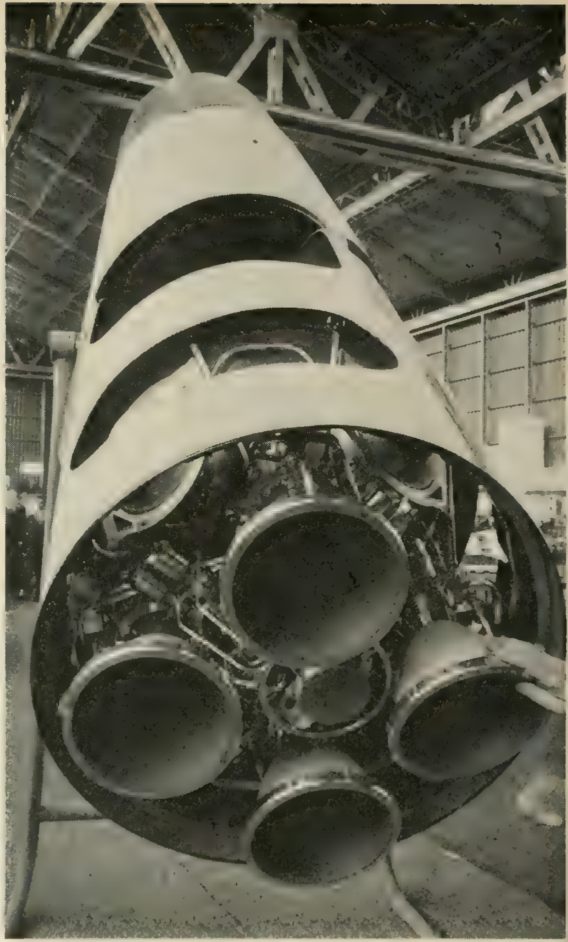
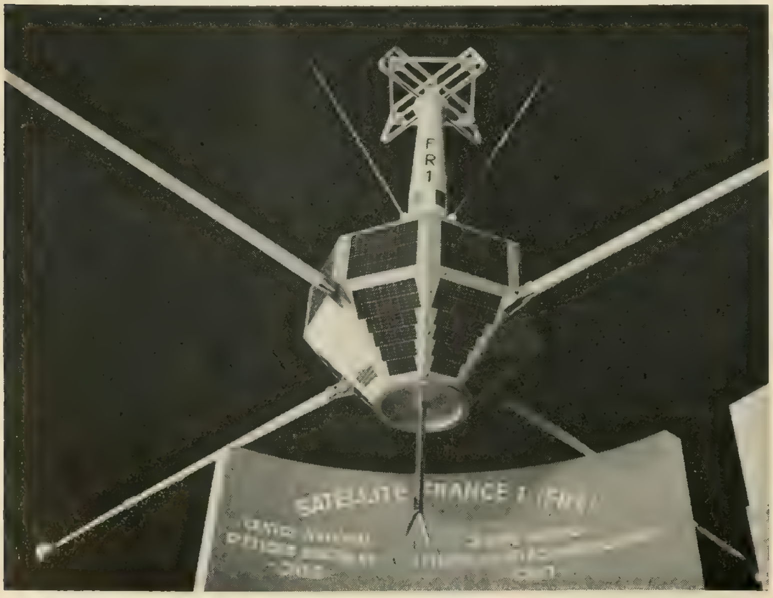
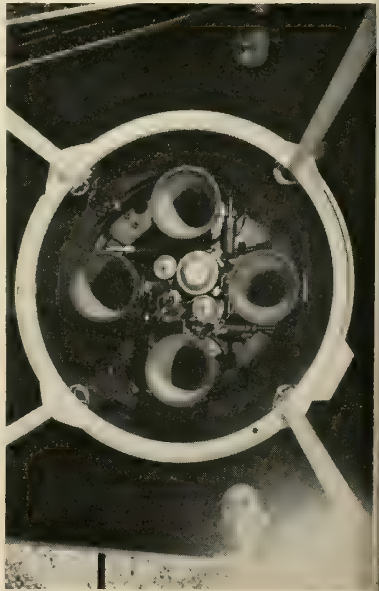




ABOVE: *First view of assembly of first-stage engine of France's Diamant rocket.* **RIGHT:** *Third stage of advanced Diamant to be powered by LOX and liquid hydrogen. Note gimballed nozzles. All photos on these pages were taken at Paris.*



SCHEDULED for launching during 1964, the first all-French satellite (FR-1) will contain a unique electromagnetic experiment. Nord Aviation will build it.



MIRROR VIEW of nozzle end of Topaze, solid-propellant second stage of Diamant.

France and Britain Prepare To Strike Out into Space on Own

British building satellite to be launched in 1966; French reveal plans for two all-French craft and show fresh details of Diamant rocket; several nations display new missiles, rockets and engines

by William Beller

PARIS—By limiting their space programs to those they can handle, France and Britain are starting to untie the apron strings binding the two countries to the U.S. space effort.

These facts became clear at the XXV Salon International de l'Aéronautique et de l'Espace, held at Le Bourget airport from June 7 to 16.

• **Significant events**—Early in the show, the British announced start of construction of *UK3*, an all-British satellite that will be designed, instrumented and completely tested in Britain before it is delivered to the U.S. in 1966 for launching.

Almost simultaneously, the French announced that Nord Aviation will build the first all-French satellite—the *FR-1*. It is to contain a novel experiment for checking out the present theory of electromagnetic wave propagation.

At the same time, a second all-French satellite—the *FR-2*—was revealed to be under design.

President Charles de Gaulle showed himself extremely well informed on space activities when he officially opened the Paris Air and Space Show. Defense Minister Pierre Messmer subsequently said that France will announce at the end of the year a seven-year program of space and missile activities.

The French also disclosed details of their *Diamant* launch vehicle. Actual hardware was shown in a setting of dramatic lighting and mirror views of hidden surfaces.

In contrast, the NASA display appeared dull and static, and seemed to offer nothing new either in content or concept.

Other highlights of the show:

—The new *Swingfire* antitank missile under development for the British Ministry of Aviation was featured on the British Aircraft Corp. (BAC) stand. The configuration of this second-generation missile, which has been classified until now, "embodies an advanced technology and remarkable all-around capability," a BAC representative said.

—New technical details of Nord Aviation's air-to-surface *AS-30* missile were released. It was also learned that a highly classified missile called *AS 33* is undergoing test. Unlike the *AS 30*, guided by manual command, the Nord *AS 33* has semiautomatic guidance. West Germany is reported to be buying this new weapon.

—A near-operational supersonic target—*CT 41*—was displayed for the first time. This Nord twin-ramjet craft of canard configuration, launched by two single-stage solid-propellant boosters, is being evaluated by the U.S. Navy at Point Mugu, Calif. The French and British are also said to be interested in the outcome of these tests.

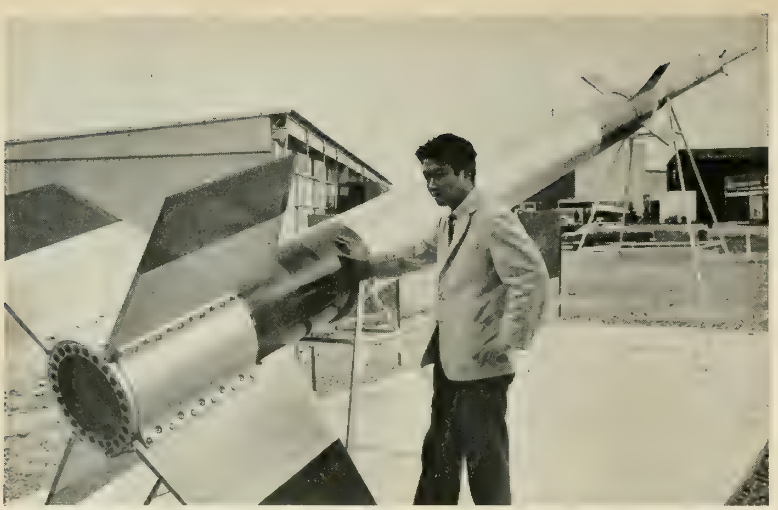
—The French showed a detailed hardware mock-up of a LOX-liquid hydrogen engine being developed for the third stage of an advanced *Diamant*.

—A three-stage sounding rocket that can be bought off-the-shelf for $35,000 was shown in static display. For sale by C. Itoh & Co., Ltd., Tokyo, *Kappa 9L* is said to be able to carry a 25-lb. payload to an altitude of 250 miles. Overall length of the rocket is 41 ft., and maximum diameter slightly more than 17 in. A company representative told MISSILES AND ROCKETS the rocket would be cheaper in quantity lots.

—The Short Bros. & Harland *Seacat* ship-to-air missile was shown deployed in a grouping of 12 instead of the usual four.

• **A way to learn**—The British Aircraft Corp., working on the *UK3* design for the past year, admittedly is developing the satellite in order to give Britain a first-hand knowledge of space technology. For this reason, Britain will not only build the *UK3* but also will give it a complete test and checkout before shipping the satellite to the U.S. for flight.

The British will thus be taking their first unaided step in satellite development, J. L. Blonstein, BAC project manager for satellites, told M/R. Britain played only a minor role in the development of two earlier U.K. satellites—the *UK1* or *Ariel*, put into orbit in April 1962; and the *UK2*, to be launched later this year. Although each of these satellites was equipped with British-built scientific experiments, the



OFF-THE-SHELF Japanese sounding rocket Kappa 9L—for sale for $35,000.

spacecraft themselves were NASA-developed and preflight-tested.

The British Ministry of Science timetable calls for the *UK3* to be launched in 1966 in a *Scout* rocket from Wallops Island, Va.

Five *UK3's* will be built—the first for structural test, the next two for environmental test, and the last two for flight and a backup.

Blonstein said the *UK3* satellites will be constructed of aluminum, because the material is lighter and gives better thermal characteristics for heat transfer than fiberglass, the structural material used on *UK1* and *UK2.*

Planned *UK3* orbit is circular, 400 miles high, and at an inclination of 57° to the equator. These are compromise parameters set up to satisfy as far as possible the requirements of all of the experiments, which are being designed by three universities and two government establishments in Great Britain.

UK3 experiments include determining electron density near the satellite; mapping galactic noise sources; studying radio signals below 20 kc; determining atmospheric distribution of molecular oxygen; and investigating the intensity and distribution of natural terrestrial noise and anomalous radio propagation.

The entire *UK3* testing program, prior to the satellites' shipment to the U.S., will be conducted by BAC at Stevenage, England, and by the space department of the Royal Aircraft Establishment at Farnborough. The Ministry of Science and the Royal Society will coordinate the experiments, just as they are doing with *UK1* and *UK2.*

- **Far-reaching experiment**—It was revealed at the show that the first all-French satellite (*FR-1*) is to orbit a unique experiment aimed at checking out current theories of electromagnetic wave propagation. First, though, the technique must be proved in a sounding-rocket test later this year, said J. P. Causse, director of satellite programs for French National Space Agency (CNES).

CNES, the French government counterpart of NASA, is charged with responsibility for *FR-1* design and construction. The French National Center for Research on Telecommunications (CNET) is putting the *FR-1* experiments together and will use the data coming out of them.

It was also learned here that Nord has won the CNES competition for building the satellite. The company will be assisted by Space Technology Laboratories.

Plans call for the *FR-1* to be launched by a *Scout* rocket fired from the Pacific Missile Range. The 50-kg satellite is to be sent on an 800-km circular orbit around the poles.

Conceived by Owen Story of CNET, the electromagnetic experiment package is made up of three mutually perpendicular antennas, located on top of the satellite and sensitive to the magnetic field of VLF waves, and dipoles sensitive to the VLF electric field.

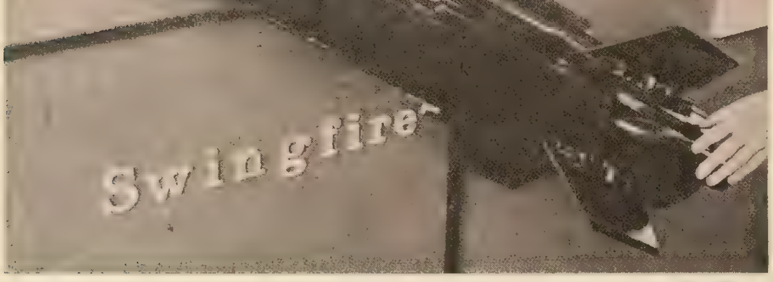
By this method, the instruments onboard will measure separately the magnetic vector **(H)** and electrical vector **(E)** of the VLF electromagnetic waves. From these two vectors, the direction of propagation of the VLF waves can easily be calculated, since it will be perpendicular to both **H** and **E.**

Causse told M/R that the *FR-1* program has been divided into two phases: in the first, the VLF experiment will be sent up in each of two *Aerobee* rockets launched from Wallops Island in September. One shot will be made during the day and the other at night in order to study the changes in the ionosphere. Ground stations at Annapolis, Md., will transmit the VLF waves.

NASA has said that if the experiment is successful it will commit a *Scout* rocket to launch the *FR-1* for a more detailed study of VLF electromagnetic phenomena.

- **French launch vehicle**—The *Diamant* three-stage rocket with which France hopes to launch a satellite in 1965 (M/R, May 27, p. 21) was shown in far more detail at the show than at any previous time. The first *Diamant* vehicle is designed to place an 80-kg satellite into an Earth orbit with a 400-km perigee and 1250-km apogee.

The first stage of *Diamant,* displayed for the first time, is said to be an advanced version of the *Véronique* rocket. Using a liquid engine called Vexin developed by LRBA (Vernon Laboratory for Ballistic and Aerodynamic Research), it is gas-pressurized and fueled



FIRST VIEW of Britain's Swingfire, second-generation antitank missile by BAC.

with nitric acid and turpentine. The engine is expected to develop about 62,000 lbs. of thrust for 88 sec. It has already been successfully test-fired, according to SEPR official Paul Douessin.

Topaze, the second stage of *Diamant* and also a solid-fueled IRBM test missile in its own right, was also shown for the first time. Successfully launched last year and said to be able to deliver 32,000 lbs. of thrust for 39 seconds, *Topaze* is controlled by four gimballed nozzles. During its test-firing, the rocket was guided and information telemetered through equipment made entirely by the French, a French engineer proudly told M/R.

Nord Aviation is prime contractor on the *Topaze* second stage, and SEPR is the chief subcontractor.

The filament-wound solid third-stage of *Diamant* was recently test-fired with highly successful results, said Laurent Janssens of SEREB. This engine has a design thrust between 5,000 and 11,000 lbs. for 45 sec. Although the prime contractor has not yet been selected, SEPR and Sud Aviation are said to be the only companies still in the running.

A second-generation *Diamant* has been funded and is under development. It is expected to be putting satellites in orbit sometime in 1967 or 1968. In connection with this version, SEPR disclosed its proposed high-energy third stage which uses LOX and liquid hydrogen.

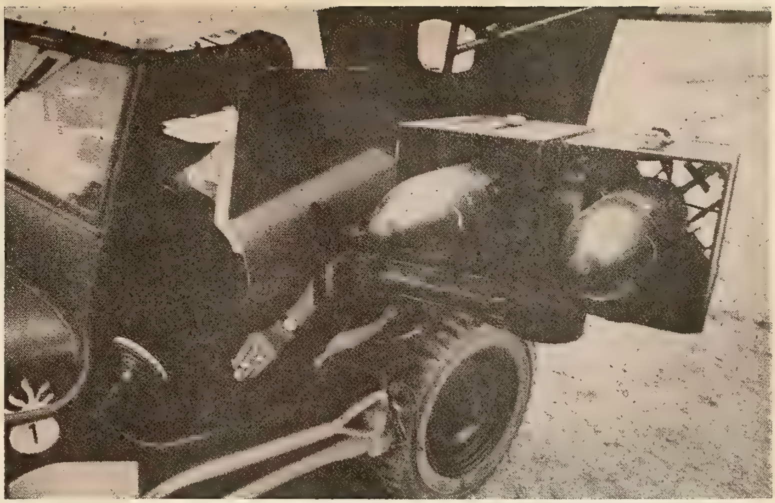
The first stage of the *Advanced Diamant,* with a thrust of 88,000 lbs. for 65 sec., looks like a scaled-up version of the first stage of the predecessor *Diamant.* The second stages of the two *Diamants* are identical.

- **Mosquito gets new sting**—Guidance of the famed Swiss antitank missile *Mosquito,* designed to be parachute-recoverable for training purposes, can now be fully automatic. With the new system, the operator, after pushing the start button to fire one of his bank of six missiles, continues to train his binoculars on the target. The signals sent into the system by the target-seeking binoculars will guide the *Mosquito* to a kill.

Contraves AG, the manufacturer, said although the usual wire-guided version scores between 70% and 90% hits, the new "position control" system is so much easier to operate that it should increase an operator's efficiency even more than the commonly used acceleration/velocity control.

Contraves pointed out that the problem in wire-guiding a missile involves two essential tasks for an operator: guiding the missile into the operator-target line-of-sight and maintaining the missile in the line-of-sight.

Getting the missile into the line-of-sight path by way of joystick manipulation has proved to be the more difficult task. Keeping the missile on the path is a severe test of the operator's power of concentration, the company says.



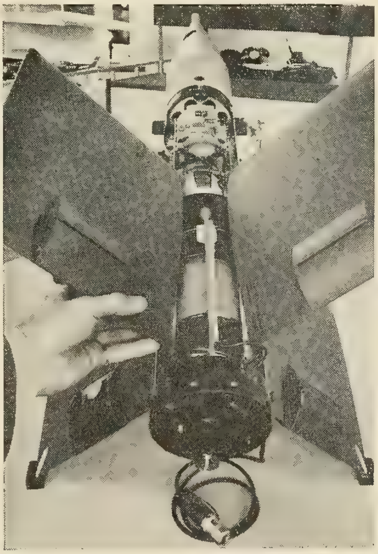
U.S. ARMY is about to place large order for French SS-11 antitank missile.

- **Multiple Seacats**—The *Seacat* ship-to-air guided missile, usually deployed four to a launcher, was shown mounted in a bank of 12 on a launcher-turret designed especially for fast patrol boats. *Seacat* is already in service with the British Royal Navy and has been ordered by a number of countries including Sweden, Australia, New Zealand and West Germany.

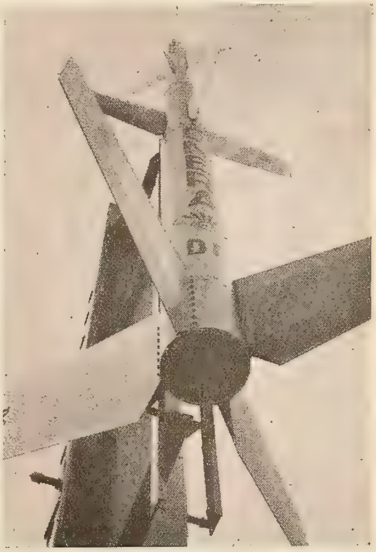
Developed by Short Brothers and Harland Ltd., *Seacat* is guided visually to its target, said Cmd. Keith Burnett of Guided Weapons Technical Sales.

As the observer trains his binoculars on an airplane, the launcher turns accordingly. When a *Seacat* is fired, it appears in his line-of-sight together with the target. The observer then manipulates a joystick until he superimposes the back end of the *Seacat* onto the target image. Flares on the *Seacat* are directed to illuminate the back end so it can be easily seen.

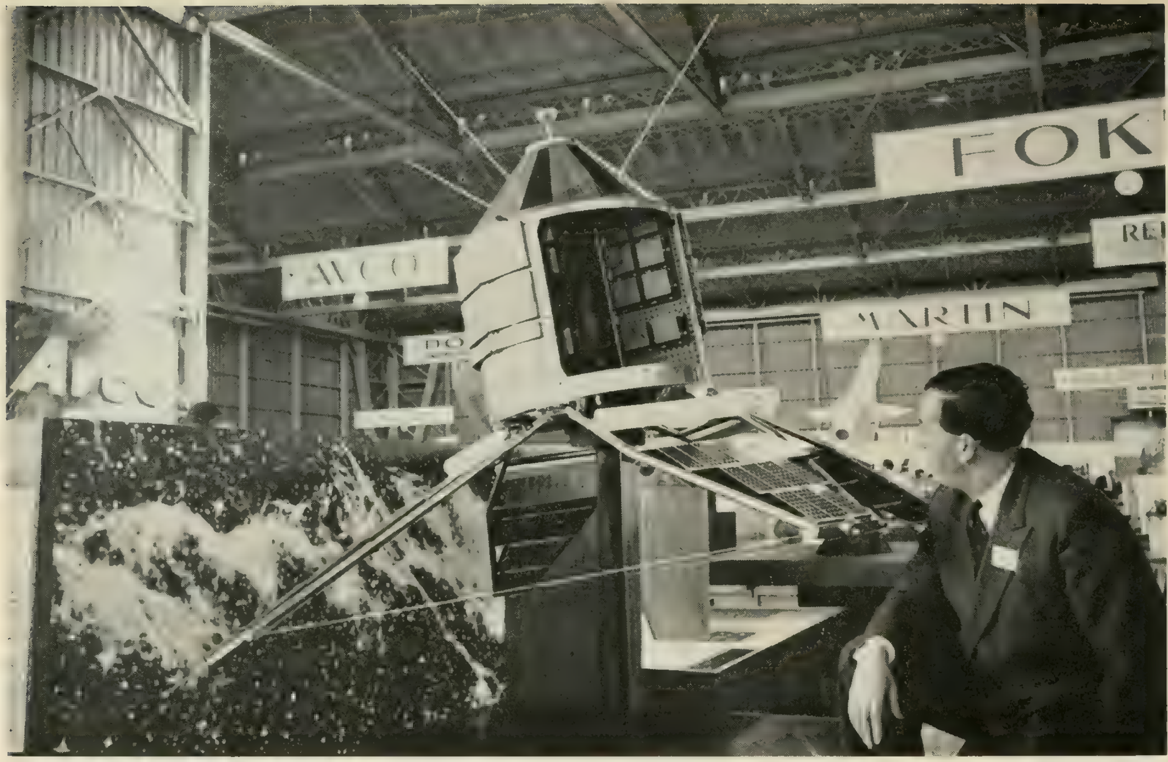
- **More about AS 30**—Newly released details about Nord's air-to-surface *AS 30* include the fact that the missile weighs about 1,100 lbs. and is 150 in. long. While performance figures are still classified, the *AS 30* high-explosive warhead is said to make the weapon comparable to a 300-to-400-mm shell in destructibility. Nord has contracts for the British Royal Air Force and the French Air Force. ■



CUTAWAY of Swiss Mosquito antitank missile shows motor and guidance system.



ONERA experimental missile for testing components of proposed supersonic plane.

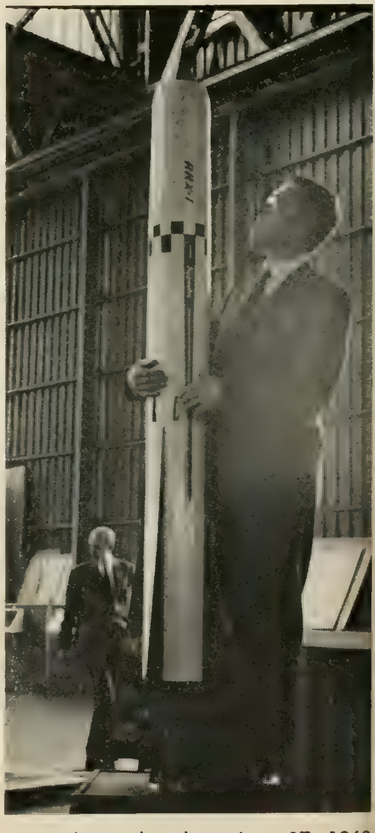


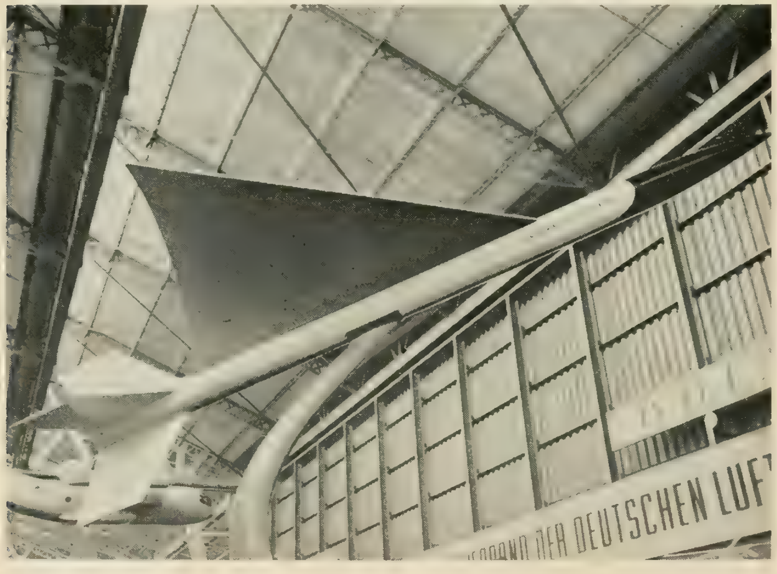
The Paris Air Show (cont'd)

ABOVE: *Recently announced UK3, first all-British satellite, is under development at British Aircraft Corporation.*

BELOW: *Dornier's recoverable sounding rocket will carry 5 kilograms to 90 kilometers. Note use of Rogallo-type wing.*

RIGHT: *Flygmotor RRX-1, Swedish rocket under design to test new ramjet concept.*





Kennedy Sees Navy's Walleye, Shrike

Antiradar missile given first public firing; show includes operational missiles and bombs

by **Frank G. McGuire**

NA LAKE, CALIF.—The Navy has President Kennedy some of its t and most effective weapons—in- g *Walleye, Shrike,* and a series f spenser-type weapons for cover- rge-area targets.

uring a June 7 Presidential visit, tional missiles such as *Sidewinder, up* and *Sparrow III* were also onstrated, along with standard ps, machine guns and unguided ts.

ne of the hottest new weapons for ort of ground troops is the *Walleye,* werful glide bomb using an ad- ed guidance system. Although it o on-board propulsion, *Walleye* is ribed by the Navy as a weapon ch will be the most accurate and ctive air-to-surface conventional on ever developed."

Veighing 1000 lbs., *Walleye* uses t Navy describes as a "homing" ance system. However, the Chief cutive was seated near a television en so that he could see exactly what missile sees as it approaches the et.

The *Walleye* used in this instance not released from the Skyhawk jet ter because a complete missile was available for firing. Thus, when the hawk made its breakaway turn from firing run, the guidance picture appeared from Kennedy's screen. vious flight tests have been made, vever, and a *Walleye* warhead was onated for the President's benefit.

No performance figures were re- sed on *Walleye,* but it was noted that weapon may replace several other mbs, unguided rockets and missiles d in attacks on heavily defended d targets. It will be compatible with modern jet fighters and attack mbers, and the Navy hopes that the Force and U.S. allies will adopt it.

The warhead is of conventional ex- sive, but is a unique design which eaks maximum havoc on the target minimum warhead weight. Demon- ated against a bridge structure, tank d truck, the warhead was extremely effective. Navy officials did not talk of *Walleye's* guidance in terms of circular error probability (CEP), but declared that it will have accuracy sufficient to "place this warhead right on the target."

• **Shrike fired**—The first public firing of the *Shrike* antiradar missile was conducted during the Presidential review. Launched from a Skyhawk fighter, it entered a high, arcing trajectory which took it far over its target and out of sight. The target, a radar transmitter, was apparently undamaged by the missile, since no explosion was seen at the site. Only one of the two scheduled firings was carried out.

Shrike, a compact, inexpensive, simple missile, can be carried by all Navy attack and fighter aircraft for use against ground defenses which depend on radar for their operation. (*Shrike* is named after the small bird which attacks the eyes of its enemies.) It is considered so reliable that no pre-launch checkout is planned after deployment.

Developed by the Naval Ordnance Test Station at China Lake, the *Shrike* guidance system will be built by Texas Instruments, Inc.

Other new weapons demonstrated to the President included *Sadeye, Snakeye, Rockeye, Gladeye,* and various other types of free-fall bombs modified with drag brakes or dispenser devices to increase effectiveness. ■

Tiros VII An Improved Storm-Spotter

NASA WILL ATTEMPT this week the seventh launching in its extremely successful *Tiros* weather satellite series.

The launch of the 297-lb. RCA-built satellite—scheduled for June 18 from Cape Canaveral—is timed to permit cloud-cover pictures during the forthcoming tropical storm season.

Tiros VII closely resembles the six successful earlier satellites in the series, but one new experiment has been added.

Besides two infrared experiments to measure the Earth-Sun heat-balance radiation relationships, the satellite will be the first *Tiros* to carry an electron temperature and density probe.

Tiros VII will also carry two wide-angle Elgeet lenses in both cameras. The 104-degree lenses permit a wide coverage of about 750 miles on each side of the satellite and are well suited to tropical storm-hunting.

The launch path of the new *Tiros* extends in a northeasterly direction from Cape Canaveral, parallel to the east coast of the U.S., out over the North Atlantic into an orbit with an angle of inclination of 58 degrees to the Equator. Although NASA technicians will concentrate the satellite's cameras over tropical storm areas, the angle of inclination will permit cloud-cover picture coverage over an area ranging almost from the Arctic to the Antarctic.

It will circle the Earth in a 400-mi. orbit about once every hour and 38 min.

The electron temperature and density probe will be similar to the probe employed in the *Explorer XVII Atmospheric Structures Satellite,* launched earlier this year by NASA.

This 13-in. probe is mounted on the spacecraft baseplate. A voltage difference is applied between the probe and the spacecraft. The amount of current flowing to the probe indicates the kinetic energy and number of electrons; thus, an indication of their temperature and density can be determined by analysis after the data have been telemetered to the ground. Data will be evaluated at the Goddard Space Flight Center.

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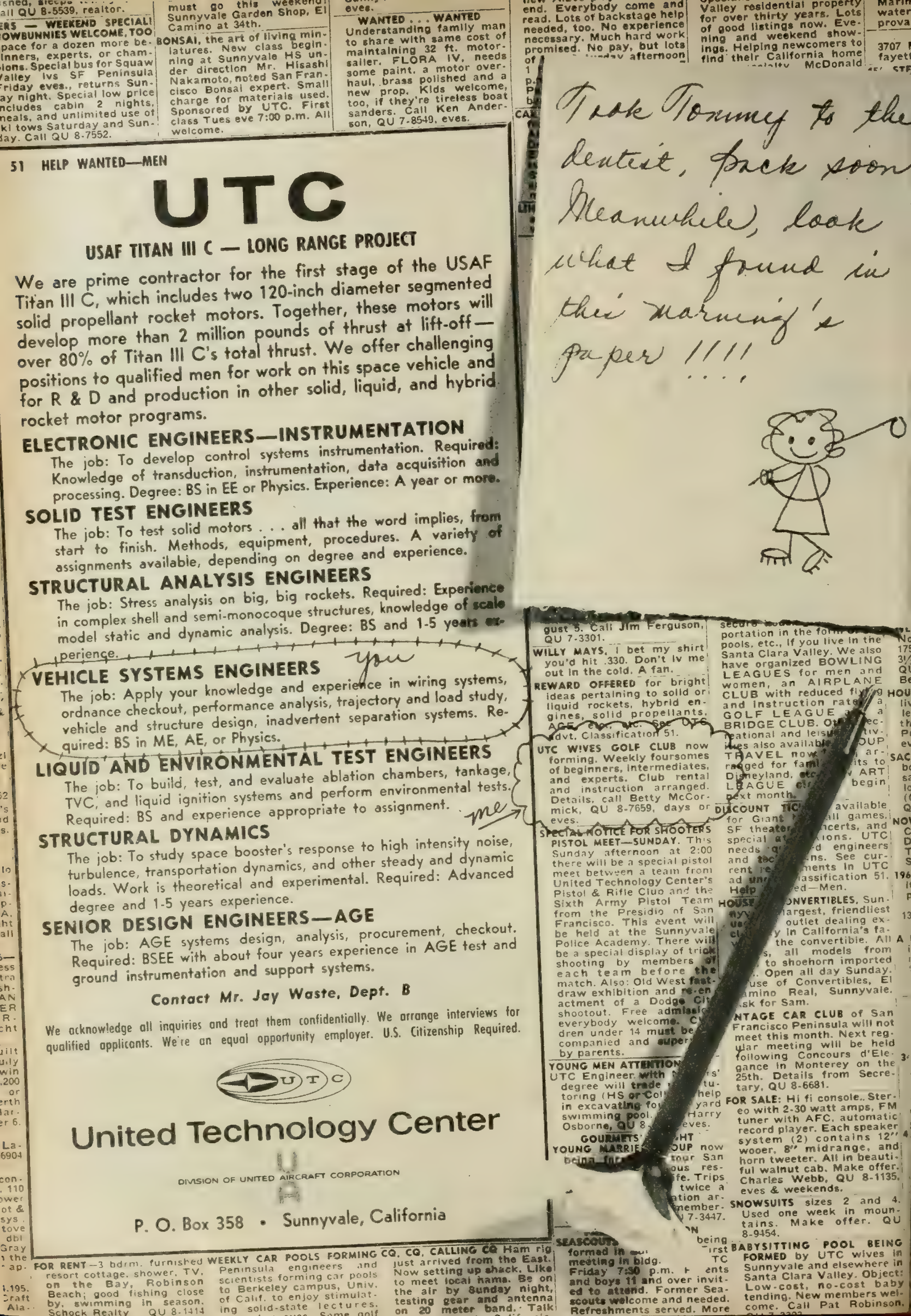

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all QU 8-5539, realtor.

ERS — WEEKEND SPECIAL! OWBUNNIES WELCOME, TOO pace for a dozen more beinners, experts, or champions. Special bus for Squaw Valley lvs SF Peninsula Friday eves., returns Sunay night. Special low price ncludes cabin 2 nights, meals, and unlimited use of ki tows Saturday and Sunday. Call QU 8-7552.

must go this weekend! Sunnyvale Garden Shop, El Camino at 34th.

BONSAI, the art of living miniatures. New class beginning at Sunnyvale HS under direction Mr. Hisashi Nakamoto, noted San Francisco Bonsai expert. Small charge for materials used. Sponsored by UTC. First class Tues eve 7:00 p.m. All welcome.

eves.

WANTED . . . WANTED Understanding family man to share with same cost of maintaining 32 ft. motorsailer. FLORA IV, needs some paint, a motor overhaul, brass polished and a new prop. Kids welcome, too, if they're tireless boat sanders. Call Ken Anderson, QU 7-8549, eves.

end. Everybody come and read. Lots of backstage help needed, too. No experience necessary. Much hard work promised. No pay, but lots of [illegible] afternoon

Valley residential property for over thirty years. Lots of good listings now. Evening and weekend showings. Helping newcomers to find their California home [illegible] McDonald

51 HELP WANTED—MEN

UTC

USAF TITAN III C — LONG RANGE PROJECT

We are prime contractor for the first stage of the USAF Titan III C, which includes two 120-inch diameter segmented solid propellant rocket motors. Together, these motors will develop more than 2 million pounds of thrust at lift-off—over 80% of Titan III C's total thrust. We offer challenging positions to qualified men for work on this space vehicle and for R & D and production in other solid, liquid, and hybrid rocket motor programs.

ELECTRONIC ENGINEERS—INSTRUMENTATION

The job: To develop control systems instrumentation. Required: Knowledge of transduction, instrumentation, data acquisition and processing. Degree: BS in EE or Physics. Experience: A year or more.

SOLID TEST ENGINEERS

The job: To test solid motors . . . all that the word implies, from start to finish. Methods, equipment, procedures. A variety of assignments available, depending on degree and experience.

STRUCTURAL ANALYSIS ENGINEERS

The job: Stress analysis on big, big rockets. Required: Experience in complex shell and semi-monocoque structures, knowledge of scale model static and dynamic analysis. Degree: BS and 1-5 years experience.

you

VEHICLE SYSTEMS ENGINEERS

The job: Apply your knowledge and experience in wiring systems, ordnance checkout, performance analysis, trajectory and load study, vehicle and structure design, inadvertent separation systems. Required: BS in ME, AE, or Physics.

LIQUID AND ENVIRONMENTAL TEST ENGINEERS

The job: To build, test, and evaluate ablation chambers, tankage, TVC, and liquid ignition systems and perform environmental tests. Required: BS and experience appropriate to assignment.

me

STRUCTURAL DYNAMICS

The job: To study space booster's response to high intensity noise, turbulence, transportation dynamics, and other steady and dynamic loads. Work is theoretical and experimental. Required: Advanced degree and 1-5 years experience.

SENIOR DESIGN ENGINEERS—AGE

The job: AGE systems design, analysis, procurement, checkout. Required: BSEE with about four years experience in AGE test and ground instrumentation and support systems.

Contact Mr. Jay Waste, Dept. B

We acknowledge all inquiries and treat them confidentially. We arrange interviews for qualified applicants. We're an equal opportunity employer. U.S. Citizenship Required.

United Technology Center

DIVISION OF UNITED AIRCRAFT CORPORATION

P. O. Box 358 • Sunnyvale, California

Took Tommy to the dentist, back soon
Meanwhile, look what I found in this morning's paper !!!!

gust 5. Call Jim Ferguson, QU 7-3301.

WILLY MAYS, I bet my shirt you'd hit .330. Don't lv me out in the cold. A fan.

REWARD OFFERED for bright ideas pertaining to solid or liquid rockets, hybrid engines, solid propellants, AGE, etc., etc. See UTC advt, Classification 51.

UTC WIVES GOLF CLUB now forming. Weekly foursomes of beginners, intermediates, and experts. Club rental and instruction arranged. Details, call Betty McCormick, QU 8-7659, days or eves.

SPECIAL NOTICE FOR SHOOTERS
PISTOL MEET—SUNDAY. This Sunday afternoon at 2:00 there will be a special pistol meet between a team from United Technology Center's Pistol & Rifle Club and the Sixth Army Pistol Team from the Presidio of San Francisco. This event will be held at the Sunnyvale Police Academy. There will be a special display of trick shooting by members of each team before the match. Also: Old West fast-draw exhibition and re-enactment of a Dodge Cit[illegible] shootout. Free admissi[illegible] everybody welcome. C[illegible] dren under 14 must be [illegible] companied and super[illegible] by parents.

YOUNG MEN ATTENTION UTC Engineer with [illegible]rs' degree will trade [illegible] tutoring (HS or Col[illegible] help in excavating fo[illegible] yard swimming pool. [illegible] Harry Osborne, QU 8[illegible] eves.

GOURMETS' [illegible]HT
YOUNG MARRIE[illegible]OUP now being for[illegible] tour San [illegible]ous res[illegible]fe. Trips [illegible] twice a [illegible]ation ar[illegible]member[illegible] 7-3447.

[illegible]N

SEASCOUTS [illegible] being formed in [illegible] first meeting in bldg. [illegible]TC Friday 7:30 p.m. [illegible]ents and boys 11 and over invited to attend. Former Seascouts welcome and needed. Refreshments served. More

secure [illegible] portation in the form [illegible] pools, etc., if you live in the Santa Clara Valley. We also have organized BOWLING LEAGUES for men and women, an AIRPLANE CLUB with reduced fly[illegible]g and instruction rate[illegible] a GOLF LEAGUE a[illegible] a BRIDGE CLUB. Ot[illegible]ec-reational and leisu[illegible]tiv-ities also availab[illegible]OUP TRAVEL now [illegible] ar-ranged for famil[illegible]its to Disneyland, etc. [illegible] ART LEAGUE [illegible] begin next month.

DISCOUNT TIC[illegible] available for Giant [illegible]all games, SF theater[illegible]ncerts, and special at[illegible]ions. UTC needs q[illegible]d engineers and tec[illegible]ns. See current re[illegible]ments in UTC ad un[illegible]assification 51. Help [illegible]ed—Men.

HOUSE [illegible]ONVERTIBLES. Sun[illegible] largest, friendliest us[illegible] outlet dealing ex-cl[illegible]y in California's fa-v[illegible] the convertible. All [illegible]s, all models from [illegible] to shoehorn imported [illegible]. Open all day Sunday. [illegible]use of Convertibles, El [illegible]amino Real, Sunnyvale. [illegible]sk for Sam.

[illegible]NTAGE CAR CLUB of San Francisco Peninsula will not meet this month. Next regular meeting will be held following Concours d'Elegance in Monterey on the 25th. Details from Secretary, QU 8-6681.

FOR SALE: Hi fi console.. Stereo with 2-30 watt amps, FM tuner with AFC, automatic record player. Each speaker system (2) contains 12" wooer, 8" midrange, and horn tweeter. All in beautiful walnut cab. Make offer. Charles Webb, QU 8-1135, eves & weekends.

SNOWSUITS sizes 2 and 4. Used one week in mountains. Make offer. QU 8-9454.

BABYSITTING POOL BEING FORMED by UTC wives in Sunnyvale and elsewhere in Santa Clara Valley. Object: Low-cost, no-cost baby tending. New members welcome. Call Pat Robinson,

FOR RENT—3 bdrm. furnished resort cottage, shower, TV, on the Bay, Robinson Beach; good fishing close by, swimming in season. Schock Realty QU 8-1414

WEEKLY CAR POOLS FORMING Peninsula engineers and scientists forming car pools to Berkeley campus, Univ. of Calif. to enjoy stimulating solid-state lectures.

CQ, CQ, CALLING CQ Ham rig just arrived from the East. Now setting up shack. Like to meet local hams. Be on the air by Sunday night, testing gear and antenna on 20 meter band. Talk

Technical Countdown

MATERIALS

Universal X-Ray Diffractometer In Development

A single crystal diffractometer attachment device for X-ray machines is in development at Materials Research Corp. under an Air Force contract. The unit will operate in a range from ambient temperatures to 2500°C in high vacuum or in inert atmospheres, accommodating single and polycrystalline materials in pellet, wire and other fabricated forms. The device could eventually provide X-ray diffractionists and crystallographers with a single diffractometer attachment to service virtually all possible needs.

Carbon/LOX Explosion Hazard Avoided

A method of avoiding the explosive hazard inherent in exposing carbon to LOX while using self-lubricating carbon parts in cryogenic systems has been perfected at NASA's Lewis Research Center. Shaped parts of carbon solve lubrication problems at the ultra low temperatures, but the addition of LOX has usually resulted in explosions. Researchers at Lewis report good results using mechanical carbons imbedded in graphite. In addition to permitting self-lubrication in LOX, the mechanical carbons transfer films to aid in the lubrication of other bearings and seals.

Curtiss-Wright Builds Maraging Bottles

The Curtiss-Wright Corp. will design, fabricate and test four 40-in.-diameter rocket motor cases using 18% nickel mar-aging steel under a research contract from the Research and Technology Division, Air Force Systems Command. Edwards AFB, Calif. Earlier experience with the high-strength nickel steels in such pressure vessels resulted in minimum biaxial yield strengths of 325,000 psi, considerably higher than the current D6AC chambers yield of 240,000 psi. Mar-aging steels, with a strength-to-density ratio of more than one million, compare favorably with filament-wound structures. The nickel-steel formula will be used extensively in the large solid rocket program recently announced by DOD.

Thick Aluminum Welds Derived from Nova Study

Welding techniques for the joining of 2014 and 2219 aluminum alloys up to 1.5 in. thick have been developed at General Dynamics/Astronautics as part of their NASA *Nova* study contract. The alloys can be joined in the flat, vertical and horizontal positions. The techniques were developed with Linde Missile Makers using metallic and inert gas and tungsten inert gas processes to provide class-I welds per X-ray standards. The next step in the manufacturing research program may include the new 7000 series aluminum alloys.

Westinghouse Builds Liquid Metal Loop

A liquid metal loop, designed for potassium, sodium and heir alloys, is in operation at the Westinghouse Electrical Div., Lima, Ohio. The system is capable of cooling at the ate of 225,000 Btu/hr. while reaching temperatures up to 500°F. Electromagnetic pumps move the liquid metals at low rates of 12,500 lbs./hr. The system includes an oxide control and indicating devices to monitor the amount of potassium oxide in the potassium metal (the oxide is directly related to high corrosion effects). The loop is being used as a research tool in studying the behavior of liquid metals used as coolants on compact rotating electrical generators.

PROPULSION

Microrocket Under Contract

Rocket Research Corp. will design and build what is reported to be the world's smallest chemical rocket engine under a $173,443 contract from the Rocket Propulsion Lab at Edwards AFB, Calif. The unit will use high energy propellants, and company officials claim the design is based on new concepts in rocket technology. The engine will be used to control satellites. The propellant valves will be developed by Whittaker Controls and the Guidance Div. of Telecomputing Corp. under a contract from Rocket Research.

ELECTRONICS

New MM-wave Space Scope Operational

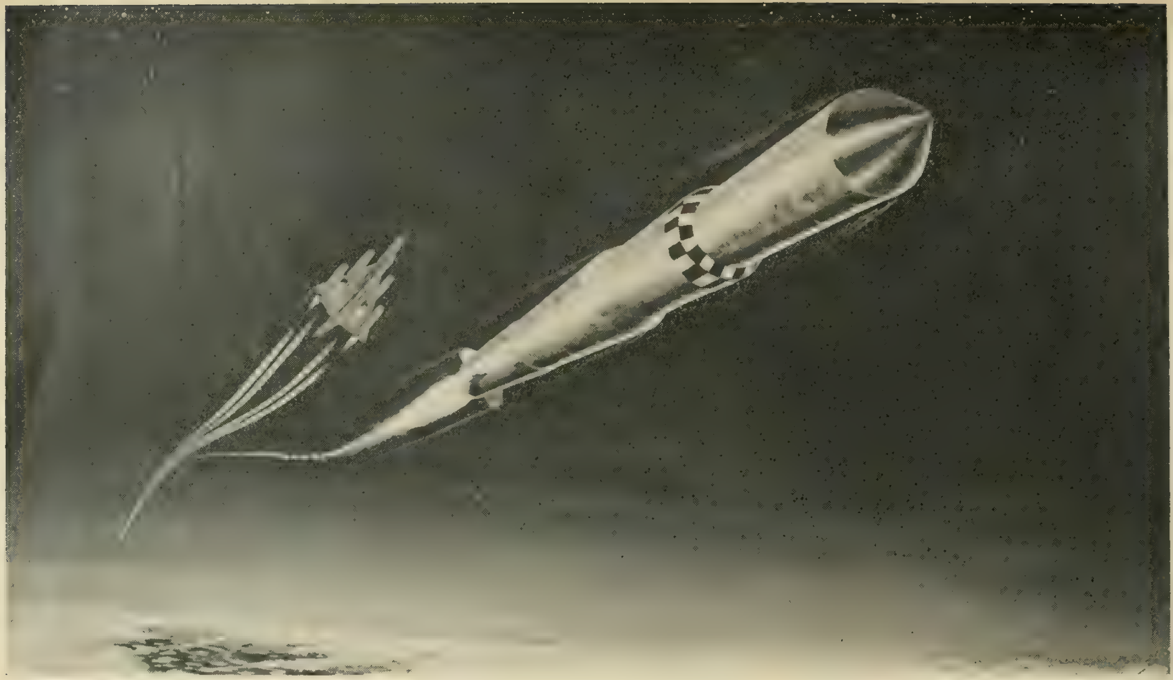
The University of Texas' new millimeter-wave radiotelescope facility near Austin will open a broad new avenue for space and planetary studies. Sponsored by NASA, the unique astronomical instrument was built by Philco Corp.'s Western Development Laboratories at Palo Alto, Calif. Using a hand-polished Invar, 16-ft. paraboloidal reflector antenna, the system will be operated over a frequency range of 10-150 gc, although it is capable of operating up to 300 gc. The antenna, according to Philco, has the narrowest monolobe beamwidth and the highest gain ever achieved (0.058 degree and 67.8 db at 70 gc). The 26,000-pound telescope is mounted on a dual drive gimbal mount. Slewing rate, azimuth and elevation, is 1 degree/sec. Position readout is accurate to ±0.001 degree, developers claim.

Techniques, Not Hardware, Limiting G&C

The success or failure of U.S. space ventures over the next few decades will depend to a large extent on guidance and control, according to Dr. Bernard Friedland, of General Precision Inc.'s Aerospace Research Center. A growing problem, he disclosed recently, is the fact that hardware development is overshadowing the development of concepts permitting more effective use of such components. Too often, said Friedland, space mission failures are related directly to an over-reliance on fallible hardware.

Millimeter Communications Band Broadened

A series of research advances in millimeter communications are coming out of the labs at Sylvania Electric Products Inc. One involves the perfecting of a portable millimeter system operating at 50 gc. The second is a demonstration in one of the firm's developmental systems that power sources for transmitters and receivers are no longer a major block in the application of millimeter waves. The third concerns the demonstration of the feasibility in solid-state communications systems above the 35-gc range through what Sylvania officials term "advanced circuitry."



FOUR-STAGE high-altitude probe is launched from B-58 in artist's conception.

An M/R exclusive . . .

Launch Platforms Gaining Acceptance

Booz-Allen study shows B-58/Scout combination might save 40% in high-altitude probe launch costs

by John F. Judge

STUDIES AT Booz-Allen Applied Research, Inc. indicate high-performance aircraft coupled with *Scout* boosters may lead to 40% savings in launch costs of high-altitude probes, and also allow broad flexibility in launch sites and time.

An exhaustive analysis resulted in selection of the B-58 "Hustler" bomber, carrying a booster combination similar to the SLV-1B (small *Scout* vehicle). This combination can push 120-lb. payloads to altitudes greater than 15,000 nautical miles. A comparable ground launch could loft only 40 lbs. to that altitude.

In addition, added potential exists in such a system to increase the payload to 300 lbs. in high-altitude probes or to place 1,500 lbs. in low Earth orbit.

The study, performed by J. W. Locke and P. G. Fielding for the Air Force's Office of Aerospace Research and Special Weapons Center, establishes that the air launching of large space probes is feasible.

The Air Force's *Jaguar* and the Navy's *Caleb* programs inspired the study.

Locke and Fielding conclude that the B-58 offers the best potential as a launch vehicle because of its high performance and the relatively minor structural changes it would have to undergo. It also has a good program growth potential.

The Booz-Allen experts contend that equivalent ground-launch systems costs are at least 1.5 times that of the air launch. No matter what launch vehicle is used, wide dispersions in apogee altitudes will result because the apogee altitudes of interest are directly related to burnout velocity.

The study's major concern was to evaluate the performance and cost effectiveness of typical space vehicle/aircraft combinations capable of sending payloads in the 30 to 120-lb. range to altitudes of 20,000 nautical miles or more. A corollary aim was to compare the results with performance and cost factors for similar ground launchings.

- **Inexpensive solids used**—In arriving at rocket motor selection, Locke and his associates limited their list to solid-propellant units. In the approach, the standard burnout velocity equation was used to categorize the capabilities of a multitude of four-stage motor combinations for an average launch-angle assumed to be 30°.

Each combination was then described in terms of physical and motor characteristics of each stage and of all stages combined using empirically-derived relationships to cover such things as fin sizes, spin rocket weights and payload compartment sizes.

The computer program was so written as to systematically select combinations of stages, determine vehicle characteristics and compute the resultant performance in terms of burnout velocity.

The restrictions in the computer program included:

—The total velocity increment from

CATEGORY	AIR LAUNCH SYSTEM		GROUND LAUNCH SYSTEM	
Unit Cost				
Rocket Motor Costs				
Equivalent First Stage	——		$ 90,000	
Stage 1	$ 63,000		63,000	
Stage 2	39,000		39,000	
Stage 3	24,000		24,000	
Stage 4	5,000		5,000	
Sub-total (C_{RM})		131,000		221,000
Vehicle Assembly Cost (2 x C_{RM})		262,000		442,000
Mounting and Check-out Costs (.10 x C_{RM+A})		39,000		——
Launch Pad and Check-out Costs (.15 x C_{RM+A})		——		99,000
Range User Costs		60,000		60,000
Total Cost—One Vehicle		**$492,000**		**$832,000**
Program Cost				
60 Launch Vehicles	$29,520,000		$49,920,000	
Aircraft Maintenance	407,000		——	
Fuel and Oil Costs	106,000		——	
Crew Costs	153,000		——	
Aircraft Modifications (Beam Pylon)	176,000		——	
TOTAL PROGRAM COSTS	**$30,362,000**		**$49,920,000**	

SYSTEM COST COMPARISON assumes a five-year, one-probe-per-month schedule, includes three aircraft flights per launch to cover aborts and training. These costs are for bare motor hardware, with no allowance for any required or desirable alterations.

any combination must be greater than 30,000 fps with a 30-lb. payload;

—No single-stage motor could be heavier than the preceding unit in any of the stage combinations;

—No single motor could have a diameter greater than those preceding it in any staging combination.

The output of the computer program defining a large number of combinations was ordered so that those combinations having the highest burnout velocity would appear at the top of the list.

A combination to be used with each aircraft considered was then chosen from as close to the top of the list as possible within the capabilities of each aircraft.

Aerodynamic heating, flight stability and temperature limitations for stable rocket-motor operation were considered to some extent, as were other problems, but the researchers felt these could be overcome by aircraft flight path and motor ignition time considerations.

One major advantage of such a system is that it allows rapid performance assessment of newly-developed motors compared with currently available units.

The rocket is assumed to be unguided and therefore first-stage fin stabilization and spin-stabilization of the upper stages were taken into account.

- **Payload configuration**—With regard to the size limitation, Locke estimated the length of the payload compartment. Here the basic assumption was that the compartment would be the same diameter as the last stage—keeping drag and vibration to a minimum. A value of 25 lbs/ft^3 was used in estimating payload density.

A six degree of freedom computer program was used to determine the performance of the B-58/rocket combination, together with Keplerian equations from burnout through apogee.

These equations have been combined by AFSWC in what is known as the Spinning Unguided Rocket Trajectory (SPURT) program designed for a CDC 1604 computer.

The launch vehicle geometry and performance input data for each rocket motor were defined using independent characteristics for each solid motor. The B-58 was assumed to be able to carry the space vehicle to 40,000 ft. at 2,000 fps. For this condition, the optimum launch angle of about 30° is well within the ability of the Hustler.

A review of burnout velocity-altitude data indicates that the air-launched combination can send a 120-lb. payload to 15,000 nautical miles. Additional analysis performed show that burnout velocity is reduced by approximately the loss in aircraft velocity—should the aircraft be unable to meet the assumed conditions. A 10,000-ft. change in launch altitude is worth about 500 fps in burnout velocity.

The mounting arrangement—consisting of a fairing beam with straps—was designed for carrying and launching. The pylon would weigh 0.07 lbs. per pound of launch vehicle weight. The pylon fits the load pick-up points on the Hustler and can be completely jettisoned in case of malfunction.

The program cost is summarized in the table on page 27. These results indicate that the air-launch system costs are about 60% that of comparable ground launch systems, says Locke.

In evaluating costs, a program of 60 launches was assumed over a five-year period, beginning in fiscal 1965 on a one-probe-per-month basis. Initial investments for launch pads and aircraft were not included in the evaluation.

The rocket-motor combination involved uses the Hercules Powder Co. Castor as its first stage, the X259-A2 Antares for a second stage, the AJ-10 Aerojet-General unit as its third stage and the Naval Ordnance Test Station (NOTS) XM-85 motor as the fourth stage.

There are several obvious advantages in air launching high-altitude probes or low Earth satellites. For instance, the velocity achieved by the aircraft will reduce the velocity increment required of the space vehicle to place a given payload at prescribed altitudes. In addition, launch at altitudes reduces drag losses incurred by the space vehicle, thus cutting the velocity increment required.

The optimum flight path angle during rocket burning is much less for an air launch, reducing gravity losses.

A mobile launching platform such as an aircraft will permit the rapid and relatively simple deployment of probes to different parts of the Earth. It also provides a ready means for taking advantage of the maximum Earth rotational velocity in equatorial launchings,

Stages	Length ft.	Dia. ft.	Weight lb.	Fuel Characteristics				For Combinations Remaining During Launch		
				Weight lb.	C.G.* ft.	Radii of Gyration		Length ft.	Weight lb.	C.G.* ft.
						Axial ft.	Transverse ft.			
1	20.60	2.58	9,653	7,313	12.70	.89	4.50	42.49	14,015	17.07
2	9.55	2.51	3,139	2,576	6.58	.88	1.83	21.89	4,365	8.67
3	6.51	1.68	975	875	4.24	.59	1.46	12.34	1,223	5.14
4	2.17	1.43	158	138	1.32	.51	.55	5.83	248	2.28
Payload	3.66	1.43	90	0	....	...	....	3.66	90	1.83

Stages	Moment of Inertia**		Thrust lb.	Measured Condition	Exit Area in^2	Burning Time sec.	Ignition Time sec.	Burnout Time sec.	Time to Change Coefficients
	Axial ft^2 slug	Transverse ft^2 slug							
1	410	52,470	53,850	S.L.	1257	27.28	0	27.28	27.78
2	81	3,354	23,724	Vac	674	30.70	28.28	58.98	59.48
3	13	258	7,985	Vac	245	30.02	59.98	90.00	90.50
4	2	19	1,690	Vac	58	24.02	91.00	115.02	

* Center of Gravity measured from aft end of rocket nozzle.
** Moments are for combinations remaining during launch.

LAUNCH VEHICLE geometry and performance data.

NEW B.F.GOODRICH FILAMENT WINDING FACILITIES PRODUCE GIANT STRUCTURES

Extending its capability for producing filament-wound rocket motor chambers and other products, B.F.Goodrich has opened new facilities for even larger structures. Highlight of the new plant is the special winding machine (see photo) which can wind chambers up to maximum sizes for land transport.

This machine is designed to produce polar, helical, geodesic and circumferential winds—or any pattern that can be identified mathematically. Through a data track system, computer-developed winding patterns can be produced with extreme accuracy, under completely controlled environmental conditions.

Included in the new facilities are winding machines for smaller structures, and large presses for molding rubber and plastic insulators. All associated materials control, curing, finishing, inspection, and testing are likewise provided in the new plant.

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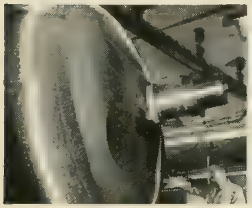

Filament wound rocket motor case

Rubber insulators for motor cases

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again cutting the required velocity increment.

A final advantage is that air launches will relieve an already overburdened launch pad schedule.

- **Platform results**—The aircraft evaluation was based on endurance, maximum weight-carrying ability, maximum dimensions of possible space vehicles and center of gravity compatibility. The B-58 had the best combinations of these. The aircraft studied included the B-52, B-58, B-66, F-101, F-105, F-104, F-106, T-38, F-4C, A-5A and F-8A.

Locke defined the launch pylon needed for the B-58 system and assumed release mechanism availability from the manufacturer of the same component on the B-58 bomb pod.

The pylon must be readily detachable from the B-58 and must contain a mechanism capable of the simultaneous release of the rocket-containing straps. The same mechanism must eject the rocket at command from the cockpit.

Electronic circuits will be used to provide a last minute checkout of the rocket just before launch—on a go-no-go basis—since the more detailed checkout would be conducted before takeoff.

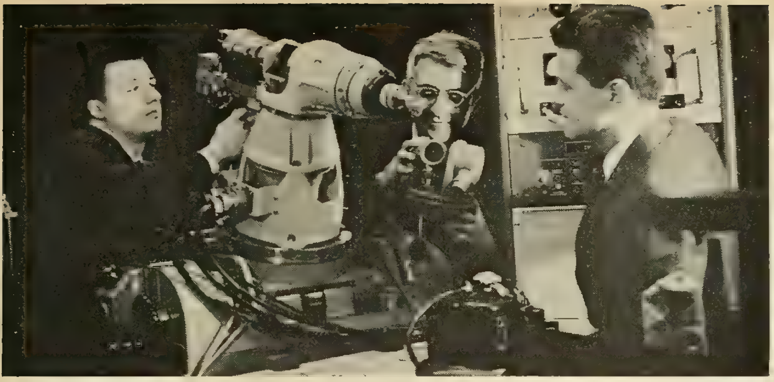
Positive control obtained from conventional "fail-safe" design techniques will provide a maximum in-flight safety factor throughout the launch cycle. The launch vehicle motors will not be ignited until the aircraft has completed its escape maneuver.

While little if any modification is envisioned for the B-58 with this pylon arrangement, the Booz-Allen team allowed a six-month period for the development and flight testing of the pylon with the understanding that this time period coincides with the entire program-development period.

Once the rocket motors have been received in an assembly area, Locke and his associates assumed a set of procedures to reach a reasonable cost figure.

For ground-launch configurations, the motors are assembled in a horizontal position within a checkout building using appropriate interstage hardware. After assurance of a good fit, the rocket is disassembled and taken to the launch pad where it is again assembled in the horizontal position. A complete systems checkout follows before the vehicle is raised to the vertical position for firing.

In the air-launched system, the motors are similarly assembled in the horizontal position and a complete checkout performed before attachment to the aircraft pylon. The entire unit is then wheeled out and fastened to the aircraft where a go-no-go check is performed. ■



ABOVE: *Experimental model of new star angle comparator gets bench check at GPI. Mock-up of proposed operational version is held by staff scientists.* **LEFT:** *"Atomic cannon" used by GPI engineers to irradiate electronic systems with gamma radiation is moved into position. The new 600,000-volt, 1500-amp X-ray flash unit subjects guidance system to radiation effects simulating a one-megaton burst two miles away at sea level.*

space electronics

Attitude System Is Based On Star-Pair Comparator

by Michael Getler

LITTLE FALLS, N.J.—A new and unique spacecraft attitude system, designed around a star-pair angle comparator, will be proposed as a possible back-up system for Project *Apollo* and as a primary system for future unmanned military and NASA space vehicles.

Developed by engineers at General Precision Inc.'s Aerospace Group here, the system basically measures the direction to any three of the 50 brightest stars (second order of magnitude or better) and then computes the angles between them to come up with a highly accurate spatial attitude determination. The measured angles are compared in an onboard memory device with a stored program of known stellar coordinates.

GPI engineers note that because of the uniqueness of the possible angular measurements between pairs of selected stars, there is rarely an ambiguity concerning star identity. They estimate that in 98% of the possible combinations, only three stars will be needed for an accurate fix.

Detection and measurement between two stars will detemine the fix, but a third star is needed to determine which of the first two is which. In the 2% of cases where there is an ambiguity, a fourth star acquisition is required.

Since the stellar angles are essentially the same (within 1 arc-sec.) when viewed from anywhere in the solar system, no compensation is required for movement in space during the time the system is operating.

● **Self-contained unit** — Engineers claim that the GPI system requires no ground or spaceborne guidance system inputs as to time, orbital path, or celestial position. It can be turned on at any time, they report, and in any attitude upon ground command or by a pre-programmed onboard computer.

The system rotates about the elevation axis at 36 rpm, with the optics continuously scanning a 5-degree field-of-view through 180 degrees in less than 1 sec. Moving in 5-degree increments, it scans through the complete celestial hemisphere in 1 min.

As the unit commences scanning, light enters the optics and is focused on a photomultiplier device (the same one used in the *Explorer* satellite series). The output is fed to a "decision" circuit which determines, by the intensity of input, whether one of the programmed stars has been acquired. If so, three-axis real-time digital readout is instantly recorded in the onboard memory and the scan continues.

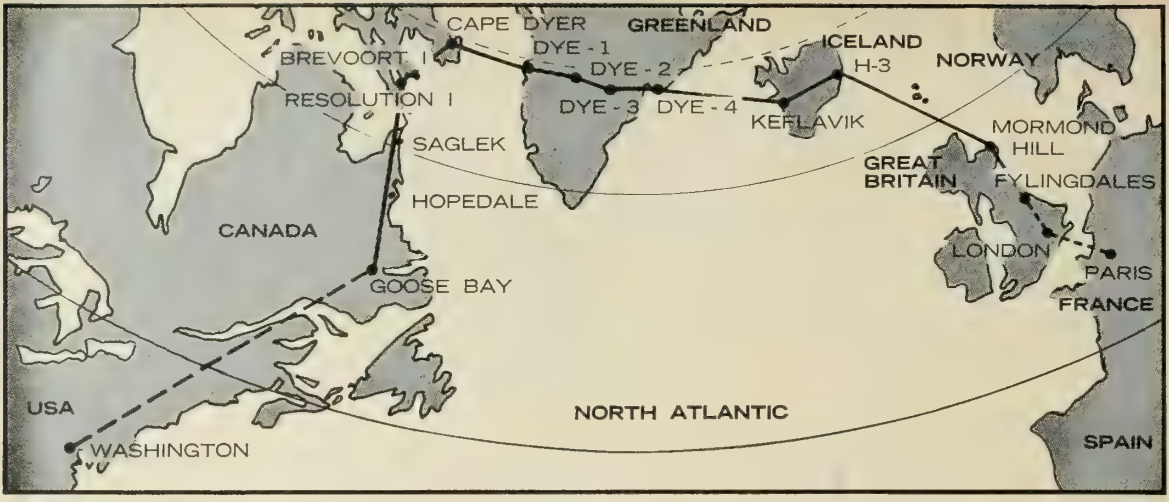
The stellar measurements are made relative to the instrument platform and are independent of other position information. After three stars have been acquired and measured and the angles between them computed, two of the stars can be identified with the star-pair, defining a known inertial coordinate reference frame. Attitude information can then be fed into the vehicle's navigation system.

An experimental model of the GPI device has been demonstrated in the laboratory for the Air Force. The system was first studied and then developed —during a total period of about three years—using both AF and GPI funds. Two separate awards, totalling about $240,000, were made by the Aeronautical System's Div. Navigation & Guidance Lab at Wright-Patterson Air Force Base. GPI reports its investment was about the same.

● **Exceeds specs**—The Air Force is reported to have acquired a 60-arc-secs system accuracy. Engineers here say that lab tests of the device have shown better than 30-arc-secs overall system accuracies, with an equivalent star tracker accuracy (minus gimbals, other hardware and digital read-out equipment) of 10 arc-secs.

The firm says studies of possible size reductions for the unit show that the current experimental model can be reduced in volume to a 7-in. x 7-in. x 7-in. package (see photo for size comparision between models), bringing it into line with the power and packaging requirements for standard star trackers.

Though currently, in demonstrations, the device is mated with its own computer element, engineers say the relatively small stored program and computational requirements for system operation would not place great demands upon the onboard computer packages that most advanced spacecraft will carry. ■



AIR FORCE'S multichannel tropospheric-scatter voice communications system was demonstrated at AFCEA.

military electronics

'Super' Global Complex Being Built

AFCEA meeting hears DCA's Starbird describe coming requirements; exhibits overflow halls; speakers warn against communications 'chaos'

by Charles D. LaFond

INTEGRATION of Federal Aviation Agency communications with the Defense Communications System is now under way, heralding a single, more effective global complex, according to Lt. Gen. A. D. Starbird.

Speaking before more than 800 of the nation's top industry, government and military leaders at the 17th Annual Armed Forces Communications and Electronics Assn. Conference recently in Washington, D.C., the Defense Communications Agency director outlined future communications requirements. These include:

—Automatic switching on a global basis (for voice and teleprinter data). This requirement will be completed by 1965, he said;

—Increased traffic handling capacity;

—Automatic communications control, display, and processing;

—Increased bypass routing capability and more hardened, dispersed communications centers, to be augmented later by military communications satellites.

• **Attendance climbs**—AFCEA conference officials reported an attendance of nearly 6,000 at the three-day conference and exhibition.

Some 180 exhibits by industry and the military departments jammed the Sheraton-Park Hotel's exhibition space, spilling over into adjoining areas.

Opening ceremonies at the conference included the first public demonstration of the Air Force's multichannel tropospheric-scatter system connecting Europe with continental U.S. military communications.

Employing 15 relay sites, voice contact was maintained between conference officials in Washington and AFCEA officials in London over the 4,625-mile two-way circuit.

A multiplicity of electronic systems shown for the first time publicly in the exhibit area included:

—The first battery-operated portable millimeter-wave radio system, shown by Sylvania Electric Products, Inc. The compact system, which operates in the 50-gc range, is expected to find application in long-range space communications (out of the atmosphere), and for secure point-to-point ground communications over short distances.

—A tiny solid-state multiplexer group, believed by Electronic Communications, Inc., designers to be the smallest yet built to meet military specs. The equipment, which weighs 243 lbs., can handle 12 voice channels from 12-60 kc by frequency-division multiplexing and by stacking 16 teleprinter channels through any one of the voice channels.

—A high-speed Photofacsimile system developed for the Army Signal Corps by the RADCOM-Westrex Div. of Litton Industries. The AN/GXC-4 was designed as a mobile system for transmitting photo or graphic data from the field to command areas. Scanning resolution is 300 lines/inch. (R-W officials also pointed out that their new unit was employed to transmit and record the first photographs point-to-point via *Telstar I*.

—A microminiaturized multi-mission radar designed by Westinghouse Air Arm Division. The system may employ either a discrete or variable frequency depending on the mission requirement and degree of resolution desired. It includes a self-check capability and provides range, rate, and angular target data.

• **Four panels**—All papers presented at this year's AFCEA conference were in association with four panels.

The first, "Communications or

MICROELECTRONICS
Microcircuits for products from airborne computers to hearing aids. Production machinery available to industry
LASER SYSTEMS
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Transistorized

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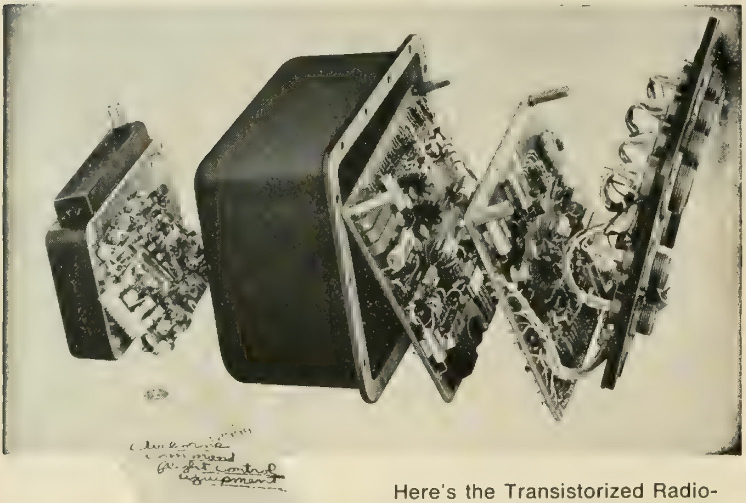

Here's the Transistorized Radio-Receiving Control Set that impressed all visitors to the RS Electronics booth with its accessibility combined with a compact, functional design.

Remote control of pilotless aircraft and missiles is achieved with this airborne unit. It provides RSE solid state reliability with the efficient packaging offered by specially designed printed circuit boards.

Consisting of a proportional decoder Model 1301A and receiver Model 2624AT, this receiving set is operated in conjunction with an airborne gyro to provide automatic flight stabilization. Line-of-sight flights may be operated without the gyro. Parachute release can be actuated by command or automatically by loss of carrier. In addition to two proportional channels for attitude control, the decoder has one auxiliary control channel.

Extra command facilities are available by mounting compatible three, five, six or ten channel RSE decoders directly on the front panel of the Model 1301A with only slight space-weight increase. The basic Model 2624AT/1301A receiver-decoder measures 7⅝" high x 7¼" wide x 5¼" deep and weighs 4 lbs. 13 oz.

SPECIFICATIONS **Frequency:** Crystal controlled, preset to any frequency between 406 and 550 Mc. **Antenna Impedance:** 50 ohms. **Frequency Modulation:** ±120 kc per attitude tone; ±60 kc for auxiliary commands. **System Sensitivity:** 10 microvolts for simultaneous operation of the attitude command system and spare command channel. **L. O. Stability:** ±0.005%. **Selectivity:** Operation with 20 microvolt signal not affected by 0.01v CW interference at ±2 Mc from carrier. **Image Rejection:** 60 db. **Spurious Response Rejection:** 60 db.

For complete specifications on the Model 2624AT/1301A or other RSE equipment to satisfy special requirements, write to:

RSE RS ELECTRONICS CORPORATION
A Division of Pacific Industries, Inc.
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7

Circle No. 13 on Subscriber Service Card

Chaos," manned by an all-General Dynamics/Electronics panel, presented a summary of problems resulting from steadily expanding global communications networks and described several new approaches to the solution.

Panel Moderator Dr. N. A. Finkelstein urged restraint by developers and users to avoid increasing the chaos. A point has now been reached, he said, where the quantity or volume of communications is contributing to a growing global disorder.

The problem, seconded panelist Fred Myers, lies with a corollary to Parkinson's Law: "The amount of data to be transmitted over any given communication link will surely expand to a point where it exceeds the traffic capacity of the link."

Industry must devote some of its vast talents to the problem and study "what" is being transmitted, instead of using all of its talent on "how" to transmit data, Myers asserted.

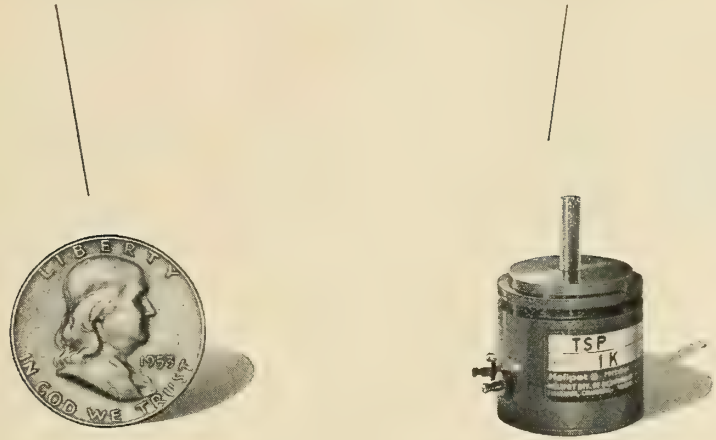
- **Problem solutions**—Solutions suggested by panelists included self-adaptive computers for data compression and on-board (satellite) editing, the use of semiconductors and delay-line storage in high-speed electronic switching, greater use of information theory to decrease error rates at the receiving terminal, increased traffic capacity by using frequency shift keying or the more advanced time-differential phase-shift-keyed transmitting techniques.

"The Management of Electronics Systems Acquisition" was discussed at length by a combined Burroughs Corp., Mitre Corp. and Air Force Electronic Systems Division panel. Systems management, engineering, and acquisition associated with the 425 L Program, the command system for the North American Air Defense Command, were discussed as representative of today's approach by the Air Force.

Requirements for the new National Military Command System and Space Communications and Tracking Systems were presented.

Two other panels included "Atlantic Missile Range—World's Largest Electronics Laboratory," presented by the Cape Canaveral Chapter of AFCEA, and "Meeting Present & Future Demands of Ground-Air-Space Communications Systems Planning." The latter panel was under the direction of ITT Communications Systems, Inc.

Keynote speaker at the opening-day luncheon was H. I. Romnes, president of Western Electric Co., who urged more effective use of engineers and scientists, particularly in light of decreasing national enrollment in technical/scientific fields. Industry, he stated, must take a more active role in the education of graduate students. ■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'Approval in principle' . . .

Navy Reorganization Plan Faces Only Grudging Acceptance

Two new commands emerge; CNO 'upgraded'; bureaus lose control of programs to new chief despite dissent of Adm. Ricketts

THE NAVY has "approved in principle" a proposed reorganization that would extensively overhaul its managerial setup to bring the Department more into line with Defense Secretary McNamara's pattern of administration.

Because the alterations stop short of the point where they would by law require Congressional approval, they are virtually an accomplished fact. Navy Secretary Fred Korth has accepted and approved most of the points recommended, although he differed on a few suggested remedies for problems.

Adm. Claude V. Ricketts, a member of the management review committee appointed by Korth to plan the reorganization, wrote a dissenting view on the establishment of a new administrative echelon between the bureaus and the existing top echelons. A change in terminology was made to satisfy his objections: the basic complaint remains, however, and it appears that the entire plan will encounter rough seas before it gains acceptance.

Other members of the advisory committee were John H. Dillon, administrative assistant to Korth; Lt. Gen. John C. Munn, USMC; Vice Adm. George F. Beardsley; and John J. Corson, management consultant.

- **New offices**—The committee recommended that two new commands—a Fleet Activities Command and a Chief of Naval Material—be created, and that the present bureau organization be modified to fit the new concept.

The Fleet Activities Command will be established under the Chief of Naval Operations (CNO) to supervise his direct fleet-support activities. The move will greatly increase CNO responsibilities, said the Navy. But other sources expressed doubt that this will turn out to be the case.

The Chief of Naval Material (CNM), a variation from the "Chief of Naval Support" which the committee recommended, will be responsible for all weapons acquisition and development and will also handle other material support for the fleet. He reports directly to the Secretary of the Navy.

The CMN thus assumes direct command of the Bureau of Naval Weapons, Bureau of Ships, Bureau of Yards & Docks, and Bureau of Supplies & Accounts—over the opposition of Adm. Ricketts, Vice Chief of Naval Operations.

Ricketts feels there is no need whatever for an administrative layer between the bureau chiefs and the CNO level—especially since the CNM now proposed would report directly to the civilian leadership in the Pentagon, not to the CNO.

Navy Secretary Korth, who claims that Ricketts now endorses the idea, following the change in terminology, will henceforth have far more direct control than he previously held over procurement and development activities.

- **Controversy brewing**—A considerable undercurrent of dissatisfaction is eroding Navy morale over the new setup, which many feel will lesson the authority of military leaders within the Navy Department. The reorganization is viewed by many high-ranking Navy officers as an attempt by Secretary McNamara to bring the Navy into line with his view of how things should be organized.

The Chief of Naval Support recommended by the management review committee would have had essentially the same responsibilities as the Korth-approved Chief of Naval Material. Officially, the reluctance to establish this new post under the CNO was explained on grounds that it would be undesirable to have the CNO directly involved with the producer side of the Navy instead of just the user side.

Unofficially, one explanation given in the Pentagon is that CNM would then be linked directly to CNO in such a way as to isolate the Secretary of the Navy—and thus the Secretary of Defense—from direct control without going through CNO.

Another reason is that reorganizations altering the statutory functions of the Navy Department would have to clear Congress. By declining the recommendation that a Chief of Naval Support be established—thus putting Congress in the act—Korth has evaded the possibility of a setback on Capitol Hill. The current plan is merely a "modification," not a structural shakeup.

However, informed sources predict that the most significant and controversial changes are yet to be made. These are reported to include redistribution of top-level management duties. They probably will occur before the end of the fiscal year.

Vice Adm. W. A. Schoech, currently deputy Chief of Naval Operations for Air, has been nominated as first Chief of Naval Material, thus assuming a new role as coordinator of fleet operational support. By enhancing the task of the CNM to include primarily the direction and coordination of project management and systems engineering, the Navy said it hopes to avoid embarrassing recurrences of situations in which a weapon system is obsolete when it becomes operational.

Some anti-McNamara observers in the Pentagon had pointed to the *Polaris* fleet ballistic missile program as an example of the effectiveness of the Navy's weapon development process. This, however, ignores the fact that a special projects office had to be set up to handle the job.

The management review committee said the bureau system had been unable to overcome its "serious weaknesses and shortcomings." Under the new concept, bureau chiefs will no longer handle major procurement projects. This job passes to CNM, while the Secretary of the Navy initiates procurement of major systems.

The Chief of Naval Operations, some Navy spokesmen unofficially feel, is becoming a more and more ambiguous title, used to describe a man who has the chore of administering shore-based facilities through the new Fleet Activities Command, despite the Navy's official position that his authority is greatly extended.

The Fleet Activities Command is a new echelon imposed between the CNO and commanders of fleet units and related short stations. Its most immediate effect will be to alter the character and responsibilities of the 14 naval district commandants.

"The Naval District Commandants," the Navy said, "will continue to perform the important mission of representing the Navy to the public in their areas." The Navy hastily added, however, that the commandants were not being relegated to the role of public relations officers. A Navy spokesman explained that their basic function hereafter will be as chiefs of "Naval Operating Bases," with the new title "Commander, Naval Operating Base and District Commandant."

- **Skepticism**—To many in the Navy's upper echelons, the language of the review proposals is significant. For example: "The Department of the Navy has found it difficult to respond to the DOD program system in a timely and proper fashion." This is viewed as one of the more significant clues to the reasons for the review, the nature of the recommendations, and the manner in which weapon system development and acquisition is now to be handled—by a man reporting to civilian rather than Pentagon military leaders.

To the statement that the CNO now has greatly increased authority, one source said grudgingly: "Maybe."

In the text of the review, the Navy's weapon-system development history was criticized in words that ring of Defense Secretary McNamara's philosophies:

"Programs are not clearly and completely mission-and-functions oriented. This deficiency also exists in planning. As a result, it is difficult to relate Navy's programs to the DOD program system, which is mission-oriented. Therefore, it is difficult to make meaningful cost-effectiveness studies and develop rational alternatives to provide a sound basis for the Navy programs submitted to the Secretary of Defense."

Disgruntled Navy leaders see this as the best clue to the reorganization zeal and its motives. They sense a repetition of the Air Force and Army reorganizations which gave DOD R&D and administrative personnel a more direct hand in shaping military activities. ■

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Max. Applied Voltage to Fuse	600 V$_{RMS}$ — 60 cps				600 V$_{RMS}$ — 60 cps	
Insulation Resistance	1000 megohms min./500 VDC				1000 megohms min./500 VDC	
Contact Resistance	0.3 ohms max.				.005 ohms max.	
Resistance (after Firing)	50 megohms min.				50 megohms min.	
ENVIRONMENTAL:						
Ambient Temperature	—100°F to operating temp.				—100°F to operating temp.	
Shock for 2-4 msec.	100 G's				50 G's	
Vibration	20 to 1000 cps at 20 G's				20 to 500 cps at 15 G's	
DIMENSIONAL:						
Body O.D. (inches max.)	.250	.250	.325	.375	.285	.250
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Where Components Must Be Improved

Marshall Space Flight Center issues detailed list as guide to contractors; longer operating life heavily emphasized

IMPROVEMENT AREA

ELECTRICAL COMPONENTS	APPLICATIONS DATA	NUCLEAR RADIATION RESISTANCE	TEMPERATURE	MATERIALS	POWER/CAPACITY	SIZE	WEIGHT	SHOCK/VIBRATION	RELIABILITY	OPERATING LIFE	EFFICIENCY/ACCURACY	STANDARDIZATION	SPACE ENVIRONMENT OPERATION
Actuators	x								x	x	x	x	
Amplifiers	x	x	x		x	x	x	x	x	x	x	x	x
Analog Plotters & Recorders					x				x		x		
Attenuators	x								x	x	x	x	
Auxiliary Power Units	x		x		x	x	x		x	x	x	x	x
Axis Torquers (Brushless Direct)		x				x	x			x	x		x
Batteries	x	x	x		x	x	x	x	x	x	x	x	x
Capacitors	x	x				x	x		x	x	x	x	x
Choppers					x	x		x		x	x		
Coils	x								x	x		x	
Computer Logic Elements	x		x	x	x	x			x	x	x	x	
Counters	x								x	x	x	x	
Crystals	x	x			x						x	x	
Delay Lines	x		x	x	x	x			x	x	x	x	
Diodes	x	x	x	x	x			x	x	x		x	
Digital Angular Position Transducers		x						x		x	x		x
Digital Pointer—Plotters, Film Copy						x			x		x		
Electrical Filters	x								x	x	x	x	
Fuses & Circuit Breakers	x								x	x	x	x	
Fuel Cells		x			x	x	x			x	x		x
Gyros	x								x	x	x	x	
Integrated Circuits		x	x						x	x	x		
Laser Continuously Operating		x						x		x	x		x
Memory Devices			x	x	x		x		x		x	x	
Micro Module		x						x	x	x	x	x	
Oscillators/Signal Generators	x								x	x	x	x	
Optical Devices and Cameras	x					x					x	x	
Potentiometers			x	x		x		x			x	x	
Printed Circuitry	x		x	x					x		x	x	
Relays	x	x						x	x	x	x	x	x
Resistors	x	x				x			x	x		x	x
Test Equipment	x								x	x	x	x	
Timers & Programers	x	x	x		x			x	x	x	x	x	x
Transducers	x	x						x	x	x	x	x	x
Transistors	x	x	x		x			x	x	x	x	x	x
Vacuum Tubes					x			x	x	x	x		

A SYSTEMATIC EFFORT to help industry improve the reliability of space vehicles has been launched by NASA's Marshall Space Flight Center.

Contractors and government personnel vitally interested in producing more reliable vehicle components have been hampered by a lack of detailed information as to which components most require improvement, and what improvements should be made.

To fill this information gap, the Marshall Center, which is in charge of the *Saturn* vehicle program, recently completed a survey of all its technical divisions. The effort was coordinated by John H. Graham, of the Applications Office of Marshall's Research Projects Division.

The two charts printed on these pages were prepared after the survey. The chart at left lists electrical components; the one at right covers the entire range of vehicle components.

- **Priority areas**—Graham listed some specific problem areas which demand special attention:

—Electrical components must stand the usual vibration and g-loads when subjected to vehicle flight; hence, industry must develop more rigorous standards and specifications than those now in general use.

—Cleanliness, often the key to component reliability, must be improved so that the finest of contaminative particles are eliminated. This is particularly important in view of the minimum of redundancy on space vehicles.

—Coupling devices or components for vehicle fuel lines must be developed so that they will insure fuel-tight connections after long periods of use in space environment. Such components should be easy to install and maintain. Also, cable connectors must be developed which can be easily and quickly connected and disconnected in space.

—All components that may possibly be exposed to nuclear radiation must be resistant to radiation damage. ■

COMPONENTS / IMPROVEMENT AREA	AGE LIFE	CAPACITY	COMPATIBILITY	CONTAMINATION	CRYOGENIC OPERATION	DESIGN	DYNAMICS	EFFICIENCY	HOT GAS	INSPECTION	INSULATION	INTER CONNECTION	LUBRICATION	MFG. TECHNIQUE	MATERIALS	PERFORMANCE	PHYSICAL PROPS	PRESSURE	PRESSURE DROP	RADIATION	RELIABILITY	SEAL LEAK	SIZE	SPACE ENVIRONMENT	STANDARDIZATION	STRENGTH	STRESS	TEMPERATURE	TESTING	VIBRATION	WEIGHT	ZERO GRAVITY
Bearings	x		x				x	x		x			x		x						x			x	x			x	x			x
Bellows	x		x	x		x						x		x	x			x	x		x	x			x		x	x		x		
Connectors			x	x						x			x		x			x		x		x	x		x			x	x			
Couplings			x	x						x			x		x			x				x	x		x			x	x			
Destruct Devices															x			x		x												
Ducts				x		x						x		x	x			x	x		x	x					x	x		x	x	
Dynamic Seals			x		x				x	x	x				x			x		x		x			x			x	x	x		
Electric Controls							x								x			x										x				
Electric Pumps		x	x	x	x								x							x		x		x	x			x				x
Encapsul. Material			x							x	x			x											x			x				
Fittings				x						x			x	x	x			x		x		x			x			x	x	x		
Flanged Joints			x		x				x	x																			x			
Flow Meters			x							x											x				x				x			
Gas Cooled Skirt	x					x			x						x												x	x		x		
Gas Generators						x		x	x												x							x		x		
Gimbal Actuators				x																x			x	x				x	x		x	
Gimbal Systems				x																x	x		x	x				x	x		x	
Heat Exchangers				x		x				x					x			x	x									x	x			
Heat Sinks						x		x		x				x	x														x		x	x
Helium				x						x	x										x	x			x			x	x			
High Flow Regulator		x		x		x									x			x			x	x						x	x		x	
Hose		x		x	x	x						x						x	x		x	x										
Hydraulic Controls				x			x				x				x			x		x		x	x					x				
Hydraulic Pumps, Fluids and Filters			x	x						x	x		x					x		x		x	x	x	x			x	x		x	
Injector (Thrust Chamber)	x					x	x	x													x	x					x			x	x	
Ignitor Initiators Squib	x						x	x								x					x			x								
Instrumentation			x		x		x		x						x			x		x								x	x	x		x
Instr. UT Cool Plate		x				x									x																	
Insulation Material	x			x	x	x		x		x					x		x			x	x	x		x	x	x	x		x	x	x	
Motor Case Assy.			x		x					x											x					x			x			
Nozzle Material	x																x				x			x		x						
Nuclear Shield											x				x					x			x		x			x	x	x	x	
Pneumatic Controls				x			x											x				x	x					x				x
Press. Regulators	x		x	x						x			x								x	x							x			
Pumps		x	x	x		x				x	x		x	x		x			x		x				x				x			x
Relief Valves (Cryog.)			x	x		x									x			x			x	x			x			x	x		x	
Sandwich Structures			x							x	x			x	x			x		x					x	x	x	x	x			
Sep. Seals & Perm. Conn.				x		x		x							x			x			x	x			x			x				
Solid Propellant	x							x									x				x			x								
Solid Prop. Material	x				x						x	x				x					x			x					x			
Static Seals			x		x				x	x	x				x	x				x		x			x			x	x	x		
Thrust Chambers	x						x							x	x			x										x		x		
Thrust Chamber Tubes															x			x									x	x	x	x		
Turbines	x								x	x	x				x			x				x				x		x	x			
Valves			x	x		x			x	x					x			x			x	x		x	x			x				

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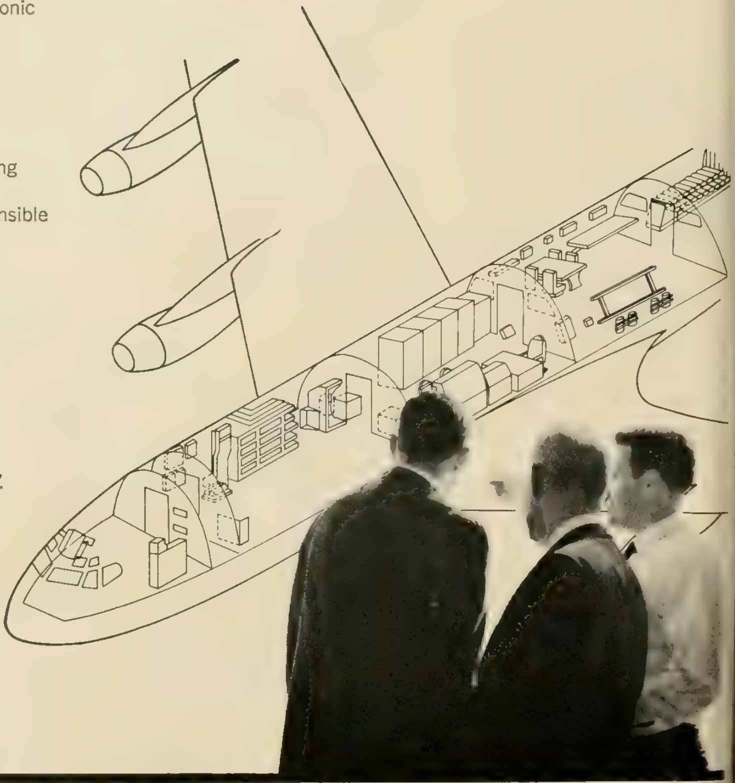

Circle No. 16 on Subscriber Service Card

New Firms and Divisions

Fairchild Stratos Corp. has formed a new Space Systems Div. in Bladensburg, Md., to handle NASA and military space programs. More permanent headquarters will be occupied by the division in August at a new technical center near Rockville, Md. Most FS scientific and engineering personnel engaged in missile/space programs in Hagerstown, Md., and Long Island, N.Y., will be transfered to the new division. . . . *The Electronic Tube Div. of Du Mont Laboratories, Clifton, N.J., divisions of Fairchild Camera and Instrument Corp., has established a new basic Advanced Research Laboratory. Coincident with the formation of the new laboratory, product development engineering laboratories have been established for each tube product line.* . . . Radio Corp. of America's Electron Tube Div. and semiconductor and materials Div. have merged into a new organization consisting of Commercial Receiving Tube and Semiconductor Div., Industrial Tube and Semiconductor Div., Television Picture Tube Div., Special Components Div., and Distributor Products. Realignment is effective July 1. . . . *Thwing-Albert Instrument Co., Philadelphia manufacturer of physical testing instrument, has formed the Sentronic Div. to manufacture the Sentronic Load Cell, an electromechanical device used to convert wight and force into a calibrated electrical pulse.* . . . Pall Corp., Glen Cove, N.Y., has formed a subsidiary, Pall Trinity Micro Corp., to market products previously sold by the corporation's Micro Metallic Div. and Trinity Equipment Corp. PTMC will specialize in design and production of compressed air and gas drying equipment, cleanable and disposable element filters, oil-removal equipment for compressed air systems, porous metals and plastics, thermocouples, and unitized dry air systems.

Mergers and Acquisitions

General Technology Corp., Torrance, Calif., has agreed to buy the vacuum products and equipment lines of Royal Research Corp., subsidiary of Royal Industries, Inc., Hayward, Calif. Acquisition is to complement and broaden GTC's activities in ultra-high vacuum space simulation. . . . *Harvey-Wells Corp., Framingham, Mass., has acquired the Michigan City, Ind., closed-circuit television business of the Dage Div. of Thompson Ramo Wooldridge Inc. Purchase did not include TRW's numerical control business, which will be moved from Michigan City to a TRW facility in Cleveland. Harvey-Wells manufactures and sells precision laboratory electromagnets and nuclear magnetic resonance equipment.* . . . Radiation Service Co., subsidiary of Radiation Inc., Melbourne, Fla., has acquired the mobile radio maintenance and installation contract responsibility of Mobile Communication, Inc., Silver Spring, Md. MCI's lease and sale operation is to continue intact, with increased technical support by Radiation Service Co. RSC has recently acquired certain assets of Federal Electric Co. in Newark, N.J., and Chicago. . . . *Huggins Laboratories, Inc., Sunnyvale, Calif., has purchased all assets of Cascade Research Corp., Los Angeles. Acquisition is to increase HLI's microwave capabilities, and expands its interests into the solid-state field.*

Industry Facilities

Beech Aircraft Corp. will open its new Boulder (Colo.) Div. space systems and products engineering complex early in July. The new building will give Beech a capacity for designing, developing, fabricating and testing space vehicle systems, subsystems and components. . . . *Minnesota Mining and Manufacturing Co.'s Mincon Div. has started construction of a 218,000-sq.-ft. administrative, sales, research, engineering and production building at Camarillo, Calif. The move to the building will consolidate Mincon activities now conducted at nine locations in Los Angeles.* . . . A Nuclear Safety Information Center is being organized at Oak Ridge National Laboratory, Oak Ridge, Tenn., to assist in coordinating the national effort in nuclear safety research and development. Sponsored by the Atomic Energy Commission, the Center will serve as a focal point for collection, storage, evaluation and dissemination of nuclear safety information generated throughout the world.

Company Representatives

Showalter-Judd, Inc., Seattle, has been appointed Washington-Oregon-Idaho-Montana sales representative for The Narda Microwave Corp. of Plainview, N.Y. . . . *A. B. Andrews & Co., Raleigh, N.C., has been named representative for original equipment sales by Tung-Sol Electric, Inc., of Newark, N.J. Andrews will handle Tung-Sol's products in Virginia, North Carolina, South Carolina, Alabama, Tennessee, and the District of Columbia.* . . . Midwest Electronic Sales, Chicago, has been named Illinois-Indiana-Wisconsin-Iowa sales representative for Electronic Associates, Inc., manufacturer of general purpose analog computers and advanced electronic equipment. . . . *Gordon-Elliot, Inc., Van Nuys, Calif., has been named Southern California manufacturers' representative for Raytheon Co.'s Commercial Apparatus and Systems Div.* . . . O. K. Staton has been named Eastern Regional Manager of Customer Engineering for Control Data Corp. of Minneapolis. Staton will direct customer service and maintenance operations on all leased and sold Control Data systems in the 20-state eastern region from CD's new offices in Rockville, Md. District operations will continue in Newark, N.J., Philadelphia and Cape Canaveral, where maintenance of CD computer systems is handled either on site or by area coordination.

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contracts

AIR FORCE

$6,000,000—**Defense Electronics, Inc.**, Rockville, Md., for supplying the Atlantic Missile Range with improved capability to receive and record missile and space vehicle telemetry data from various new and proposed missile and space programs.

$4,000,000—**Gilfillan Corp.**, Los Angeles, for electronic countermeasures systems (supplemental contract).

$3,500,000—**Control Data Corp.**, Minneapolis, for a range safety impact prediction computer system for the Atlantic Missile Range.

$2,100,000—**Ling-Temco-Vought, Inc.**, Dallas, for development of high-power tube testing facilities. Work to be performed at Dallas and Griffiss AFB, N.Y.

$1,900,000—**Radio Corp. of America**, New York City, for provision of voice communications switching system for the National Communications System.

$1,800,000—**Aerojet-General Corp.**, Azusa, Calif., for design, manufacture and production of radiometric equipment.

$1,500,000—**Collins Radio Co.**, Richardson, Tex., for production of comunications systems.

$158,500—**Garrett Corp., AiResearch Manufacturing Co.**, Phoenix, Ariz., for air turbine starter engine for the *GAM-77* guided missile.

$94,000—**Bjorksten Research Laboratories, Inc.**, Madison, Wis., for continuation of pioneering work applicable to special coatings on glass fibers.

$70,000—**Informatics, Inc.**, Culver City, Calif., for research and development on an Executive Control Program for multi-computer systems.

Thiokol Chemical Corp., Wasatch Div., Brigham City, Utah, for the study and investigation of fabrication techniques in areas associated with large segmented fiberglass rocket motor cases (undisclosed amount).

Ling-Temco-Vought, Inc., Dallas, for evaluation of a new type of propulsion system for the Astronaut's Maneuvering Unit (AMU), (undisclosed amount).

Curtiss-Wright Corp., Wood-Ridge, N.J., for design, fabrication and testing four ultra-high strength 40-in.-dia. rocket motor cases (undisclosed amount).

ARMY

$18,800,000—**Western Electric Co.**, New York City, for continued research and development on the *Nike-Zeus* missile system.

$6,300,000—**Western Electric Co.**, New York City, for continued work on the *Nike-Zeus* and *Nike X* missile weapons system (2 contracts).

$4,900,000—**Ford Motor Co., Aeronutronic Div.**, Newport Beach, Calif., for study of penetration aids of missile warheads.

$3,600,000—**Hughes Aircraft Co.**, Fullerton, Calif., for equipment to coordinate firing of missile batteries.

$2,800,000—**Douglas Aircraft Co.**, Charlotte, N.C., for *Nike-Hercules* components.

$2,500,000—**Burroughs Corp.**, Paoli, Pa., for automatic message-processing system.

$1,300,000—**Lockheed Aircraft Corp., Lockheed Propulsion Co.**, Redlands, Calif., for participation in development of propellant for *Sprint* missile system.

$1,300,000—**Magnavox Corp.**, Torrance, Calif., for automatic storage and retrieval system. Work to be performed at Torrance, and the Redstone Arsenal, Ala.

$350,000—**Thiokol Chemical Corp.**, Huntsville, Ala., for feasibility studies on a new solid propellant for the *Sprint* missile.

$350,000—**Aerojet-General Corp.**, Sacramento, Calif., for feasibility studies on new solid propellant for the *Sprint* missile.

$281,385—**Bucon Construction Co.**, Cape Canaveral, for construction of a 100′ x 150′ concrete block building on Merritt Island for NASA's use in housing plant maintenance equipment.

$182,800—**Rommel-McFerran Co., Inc.**, Louisville, Ky. for alterations to Hangar "L" at Cape Canaveral.

$37,400—**Bausch and Lomb Optical Co.**, Rochester, N.Y., for feasibility study for development of solid-state optical device for suppression of flash blindness and thermal eye burn incurred during nuclear weapon bursts.

NAVY

$3,500,000—**General Precision, Inc.**, Glendale, Calif., for ASW computer systems.

$3,500,000—**Minneapolis-Honeywell Regulator Co.**, West Covina, Calif., for production of missile system training equipment.

$2,300,000—**Aerojet-General Corp.**, Azusa, Calif., for continued production of Mark 46 torpedoes.

$1,500,000—**Hughes Aircraft Co.**, El Segundo, Calif., for production of fire control repair parts for the *Polaris* missile.

$1,300,000—**Sperry Rand Corp., Sperry Gyroscope Div.**, Syosset, N.Y., for services to shipboard inertial navigation systems.

$238,400—**Ryan Industries, Inc.**, Cleveland, for liquid oxygen storage tanks production.

$233,300—**Vitro Corp. of America, Vitro Laboratories Div.**, Silver Spring, Md., for continued research and development on missile weapons systems.

North American Aviation, Inc., Space and Information Systems Div., Downey, Calif., for provision of information on the surfaces and atmospheres of planets (undisclosed amount).

NASA

$15,000,000—**Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for design and development of the *Pioneer* solar probe.

$949,000—**Westinghouse Electric Corp.**, Houston, for Manned Spacecraft Center acceleration facility's central drive system.

$606,000—**Radiation, Inc.**, Melbourne, Fla., for telemetry antenna system.

$423,800—**Marshall Industries, Aerolab Development Co.**, Pasadena, Calif., for production of *Argo D-4* four-stage rocket vehicles.

$376,000—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., for research and development on high-expansion-area rocket nozzles.

$261,700—**Itek Corp., Vidya Div.**, Palo Alto, Calif., for a study of solid-propellant rocket motor materials behavior.

$98,000—**Ford Motor Co., Aeronutronic Div.**, Newport Beach, Calif., for study of a Mars Excursion Module (MEM).

$97,500—**James Electronics, Inc.**, Chicago, for provision of precision Micro-Scan relays to be used for static test equipment on the *Saturn* missile booster system (3 contracts).

INDUSTRY

$1,338,000—**General Precision, Inc., Kearfott Div.**, Little Falls, N.J., from the **Martin Co.**, for production of more than 200 Kearfott "Alpha" miniature floated rate-integrating gyroscopes for use in the autopilot system of *Titan III*.

$950,000—**Dalmo Victor Co.**, Belmont, Calif., from **North American Aviation's Autonetics Div.**, for radar antennas.

$500,000—**Beckman Instruments, Inc., Berkeley Div.**, Richmond, Calif., from **Lockheed Aircraft Corp.**, for two analog computers to be used in development of aircraft and space vehicles.

$141,000—**American Machine and Foundry Co., Advanced Products Group**, Brooklyn, N.Y., from **Western Electric Co.**, for production of *Nike-Hercules* acquisition antennas.

Charles Ross and Sons Co., New York City, from **Lockheed Propulsion Co.**, for delivery of a ten-gallon and 85-gallon capacity vertical mixer for use in mixing Nitroplastisol composite double-base propellants (undisclosed amount).

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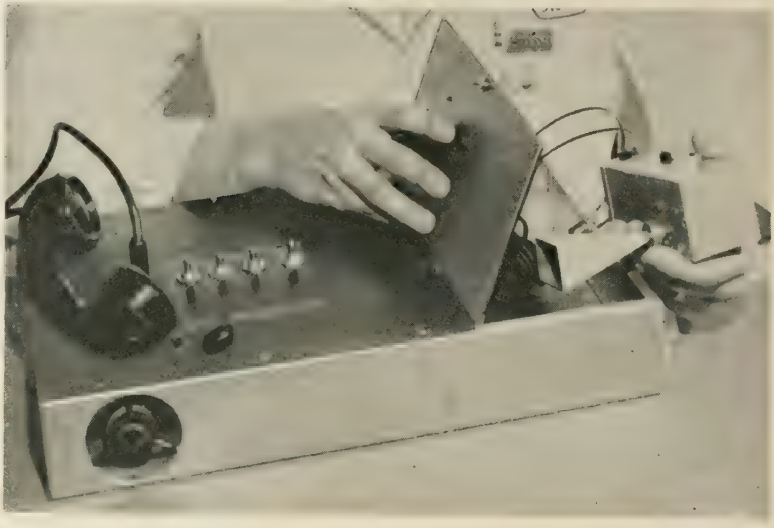

New Product of the Week:

Portable Millimeter Radio

A battery operated portable millimeter radio system for special communications is available from Sylvania Electric Products Inc.

The millimeter system, consisting of a transmitter and receiver, antennas, microphone and headset, is packaged in an attaché case for easy carrying. Millimeter systems generally are rack-mounted with external power supplies, and are usually at least five times larger than the new Sylvania package.

Three major uses of millimeter systems are: (1) long-range space communications where there is no atmosphere to absorb the radio signal; (2) point-to-point ground or air communications when a high degree of privacy is desired, and (3) high capacity city-to-city ground communications requiring high-volume information transfer.

The portable military system was developed to prove the feasibility of small, battery operated millimeter communications. Operating at 50 kilo megacycles, its potential ground range is half a mile. Larger systems would have space-to-space ranges of thousands of miles.

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X-Y Recorder

Developed by Houston Instrument Corp., the HR-96T X-Y recorders feature 1 mv/in.-10 v/in. senstivity, 100 k constant input impedance, switch-selectable stepped input attenuators, X-axis time sweep, 0.25% accuracy, electric pen lift, and snap-on pen assembly.

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Vacuum Gauge System

A vacuum gauge control (NRC Model 763) and gauge (NRC Model 553) specially designed to meet ultra-high vacuum requirements is available from NRC Equipment Corp., a subsidiary of National Research Corp. The control and gauge provide more stable, accurate readings over a wider range than other gauge systems.

The control provides for a complete vacuum gauging system in one chassis offering the option of two thermocouple gauges (2.5 × 10^{-3} torr operating range) and one ionization gauge (10^{-3} to 10^{-10} torr range). Nearly nonexistent drift is given by the control's true electrometer circuit, adding to the system's stability. The cathode follower output isolates the recording instrument used, avoiding any danger of the instrument distorting pressure readings. This operates on the 100% negative feedback principle. The control reads pressure while outgassing.

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Magnetic Logic Circuits

A ferrite multiaperture device has been developed for application in magnetic logic circuits. Designated MAD-5 wafers, the component is used in a line of magnetic logic modules offered for use as building blocks to construct com-

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He must have a personality which enables him to work easily and well with a variety of people—plus intellectual speed which permits him to react quickly to any situation. He must be inventive and imaginative, will probably hold several patents and will have had papers published in professional journals. His present position might be that of a preliminary design section head or staff head in an equipment design group.

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puting and other digital equipment. In addition, shift registers are available in a variety of bit lengths with serial or parallel access.

The units are wired to form logic modules such as OR gates, AND gates, and other circuits assembled in easy-to-handle wafers.

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Solid State Inverters

The Industrial Battery Division, Gould-National Batteries, Inc., is marketing a complete line of dc-to-ac solid-state inverters.

Wherever ac power outages prove costly and a hazard to equipment and life, the Gould Inverter will convert emergency dc battery power to ac, and will supply that power to critical loads until main power is restored.

The Gould Inverter is adaptable to such applications as data processing, telemetering, pipeline instrumentation, missile firing and tracking, nuclear reactor control and others. Of solid-state design with no moving parts, standard inverter models can be ordered with outputs up to 5 KVA (inputs 24, 48 or 120v). Units with other ratings are available.

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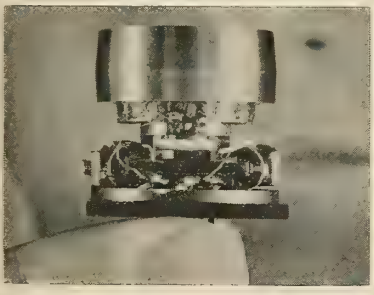
Microminiature Rate Gyro

A microminiature rate gyroscope that eliminates conventional gimbals was demonstrated here today by Special Devices Laboratories, Inc.

The highly sensitive unit, known as TeleRate, measures less than 1 cu. in., weighs 1.5 ounces and is used as a sensing or controlling device for a wide range of aerospace applications. It incorporates a new approach to gimbaling by eliminating float arrangements, delicate bearings, torsion bars and critical pick-offs without anv loss of sensitivity.



The angular momentum of the device is 62,500 gm-cm^2 per second.

The output ranges are 10 to 2,000 degrees per second with full-scale output at 1.5 volts and null at 5 millivolts. The resolution is infinite and linearity and hysteresis is 1.0% and 0.01% respectively. The natural frequency is variable with range typically 41.7 cps at 200 degrees per second.

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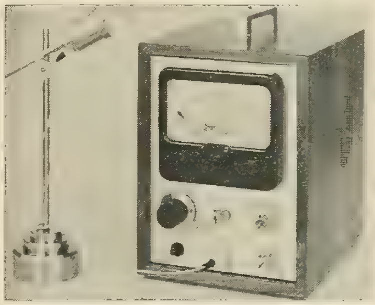
Vacuum Deposit Monitor

A micro electronic deposit thickness monitor with high control reliability has been developed by Sloan Instruments Corp.

The Model DTM-2 is designed to fill the needs of the new era of precision microcircuitry production, and is designed to offer accurate thickness control in the laboratory and future large scale production facilities.

The unit employs a vacuum-tight oscillator package with an exposed quartz crystal held in the vapor stream. As the vacuum deposit builds up, the resonant frequency of this crystal changes—the change being directly related to the deposit mass. An external frequency detector package identifies the frequency change, and has signal outputs in the form of an audible sound, a direct-reading frequency meter and external ac and dc recorder outputs. An integral meter relay can be used to automatically cut power to the deposit source at any pre-arranged thickness.



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Pancake Resolver

A high-precision two-speed pancake resolver, providing 16 and 1-speed outputs, is being produced by the Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America. Designated as the Model 48DRU816, this latest in the Reeves series of precision pancake resolvers has an accuracy of better than 10 seconds for the 16-speed output, and three minutes for the one-speed output. Corresponding phase shifts are 14 degrees and 2.4 degrees, respectively.

The assembly consists of two independent four-wire resolvers, which are wound on common rotors and stators. The two sets of windings are electrically independent, and there is no cross-coupling when either or both pairs of windings are energized.

Standard input voltage is 28v at 800 cycles, with total primary power requirements of minus 0.03 watt for the single speed windings; and 1.0 watt for the 16 speed. This unit can also be supplied at other frequencies and input voltages.

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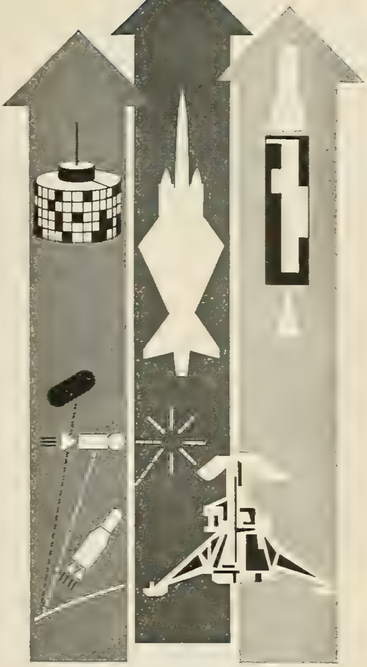

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While fuzing experience would be helpful, it is not mandatory. Broad general background knowledge and high interest in the subject *is* required.

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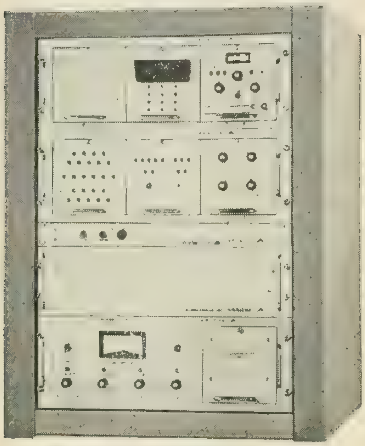

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Pulsed Servo Amplifier

Compact servo amplifiers that handle 4.5 kw with less than 10 millisecond response time are being marketed by American Electronics, Inc. In contrast to the high-command output, standby current is only 70 milliamps. Typical positioning accuracy is better than 1%.

AEI pulsed servo amplifiers may be built to virtually any power requirement. The Model 83036-2, in a typical application, powers a reversible 3-phase, 400-cps induction motor to position critical aircraft linkage to 1% accuracy, with overall system response time less than 100 milliseconds. For maximum power, the standard amplifier provides 4.5 kw continuous 3-phase output at 400 cps. Pulsed output for reduced power is adjustable to adapt to a wide range of system time constants. Efficiency at full load is approximately 99%. Standby current is less than 70 milliamps.

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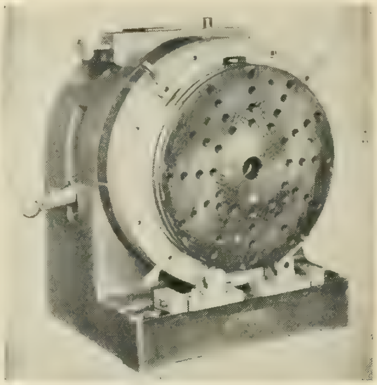
Zeroing Device

A "zeroing" adjustment that permits rotation of the entire indexing table within ±3 degrees is being marketed by AA Industries.

Loosening four thumb-actuated screw clamps releases the entire indexing mechanism for rotation. When the screws are tightened, the table may then be indexed to any one of 360 degrees with an accuracy of less than ¼ second of arc.



The unit is used in checking the accuracy of gyro-equipped space vehicle components, accelerometers and related equipment. The component to be checked is mounted on the table and located exactly in relation to its "null" position through use of the "zeroing" adjustment. When the component being checked is activated electrically, the table may then be indexed to any position and the unit calibrated according to the degree of error indicated.

Circle No. 234 on Subscriber Service Card

VLF Whip Antenna

A whip antenna system for operation from 10 kc/s to 30 kc/s, is available from Develco.

The Model 1006A VLF whip antenna system has a 20-ft. vertical mast of four 4-ft. sections. A preamplifier and filter assembly are integral parts of the system, and are provided with a jack for field strength calibration.

The amplified signal from the preamplifier is transmitted through a balanced line for remote instrumentation. The balanced line is also utilized to carry dc power to the pre-amplifier.

General specifications include: amplitude, 4 db maximum to minimum from 10 kc/s to 30 kc/s; sensitivity 1 microvolt/meter or better; dynamic range, 125 db; effective height, 1 meter; and power requirement, 15 volts at 4 milliamperes.

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Transistor Amplifier

Pioneer Magnetics, Inc. is marketing the PM 1001 precision ac transistor amplifier.

The unit is a high precision ac amplifier with four fixed-gain ranges (externally switched) of 2X, 5X, 10X, and 20X. The maximum gain error is guaranteed to be less than ±0.1% under all conditions. Designed for extreme environmental conditions, the amplifier will perform with ambient variations from —40°C to 72°C. The input impedance of the amplifier is 100,000 ohms ±0.1%. The transformer coupled output can be varied from 0 to 130v RMS maximum, with less than 0.5% distortion peak-to-peak. The phase angle error is also less than ±0.5 degree. The output impedance is less than 1,000 ohms. Rated load is 100 k ohms.

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Hermetic Seal Capacitors

Absolute humidity protection is said to be available in the new high-reliability line of hermetic seal ceramic capacitors being marketed by The Scionics Corp.

Moisture absorption in capacitors has been a major cause of field failures in military electronic systems. The hermetic seal ceramic capacitors using a glass-to-metal case seal have passed more than 90 days of continuous humidity cycling per Mil-C 11015 C, which requires only 10 days of continuous humidity cycling for qualification.

The Scionics SCH70 series capacitors come in the CK06 size package in capacities of 10 mmf. to 10,000 mmf. for 200vdc, and up to 100,000 mmf. for 50vdc. These are available with gold plated Kovar leads.

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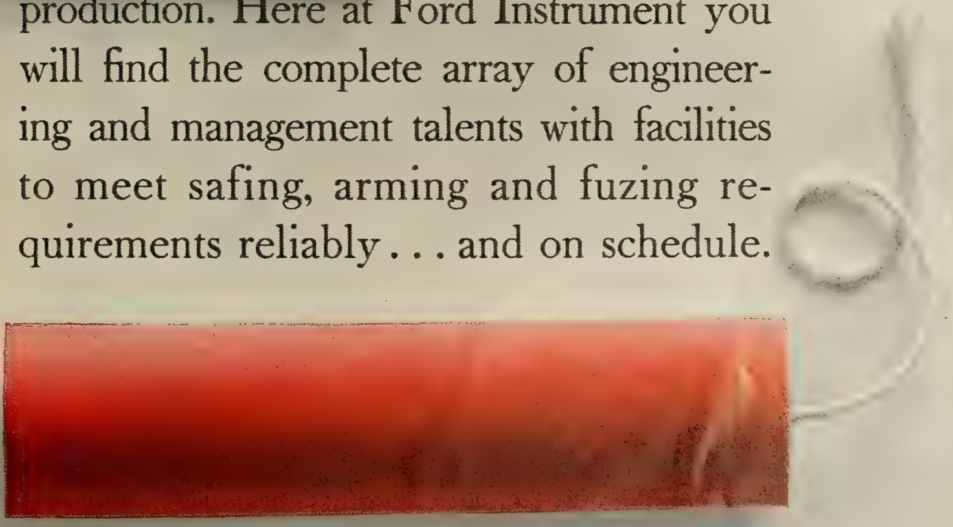

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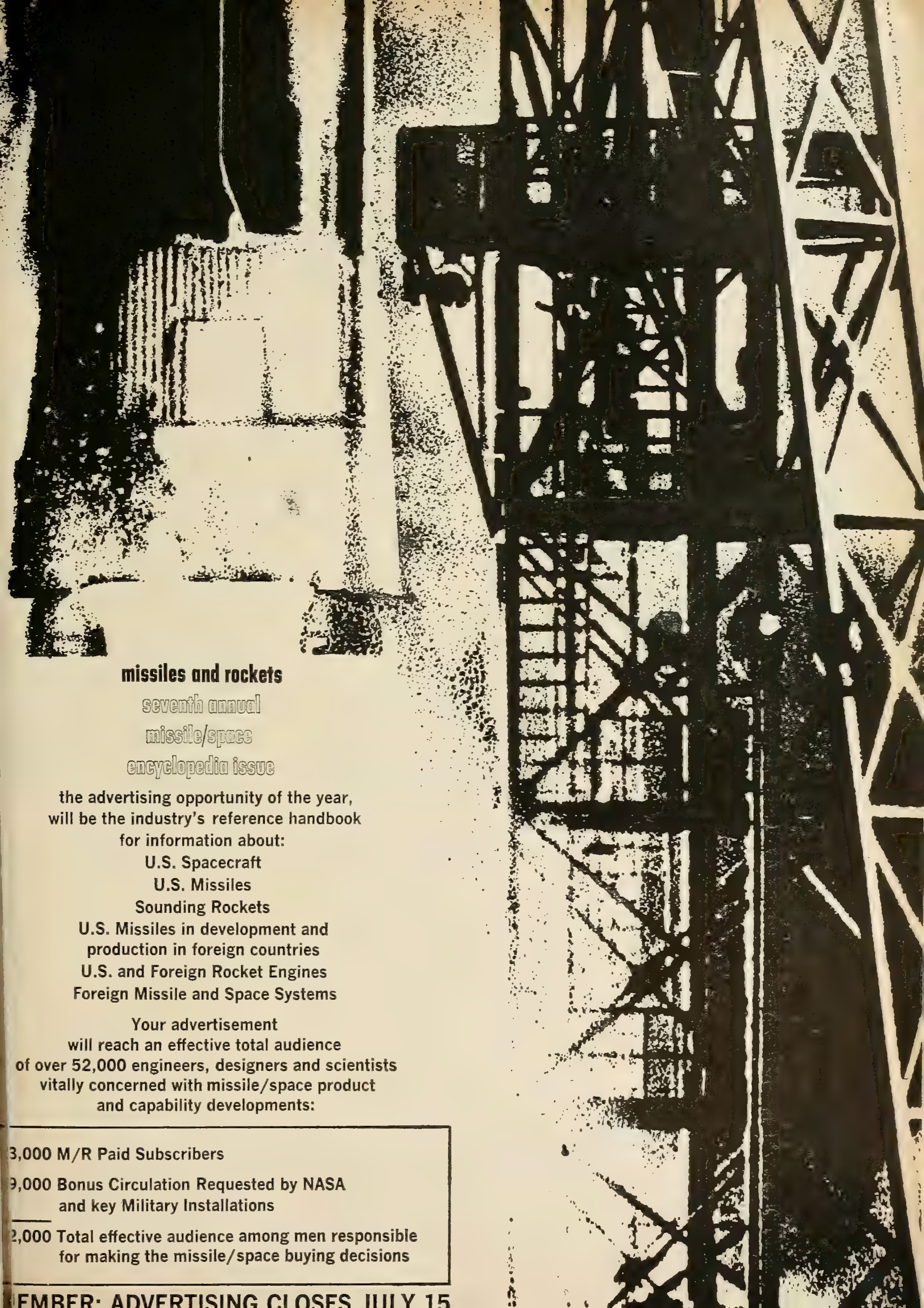

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names in the news

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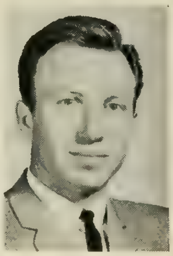

TOWNER

KING

Dr. Herman M. Case: Appointed manager of new concepts for the Martin Co.'s Orlando, Fla., Div.

Ward B. Dennis: Elevated to corporate vice president for development planning at Northrop Corp., Beverly Hills, Calif.

Albert G. Schwerin: Appointed manager-aerospace and defense systems sales in the Western Region Operation for General Electric Co.'s Defense Programs Operation, Los Angeles.

Lawrence F. Punte: Named to head the new Process Engineering Dept. at the Fairchild Semiconductor Diode Plant, San Rafael, Calif.

Jack C. Towner: Appointed sales manager and director of marketing for the Gudeman Co. of California, Inc., Visalia, Calif.

Laurence A. Shadle: Named controller of Avco Corp.'s Lycoming Div., Stratford, Conn.

Edward A. King, Jr.: Appointed director of marketing for the ACF Electronics Div. of ACF Industries, Inc., Riverdale, Md.

Edward S. Weil: Appointed sales manager of the Rectifier-Capacitor Div. of Fansteel Metallurgical Corp., North Chicago, Ill.

Herbert L. Schenck: Named Western Regional Manager for Televiso Electronics of Wheeling, Ill.

Irving Shapiro: Appointed contracts administrator for Aerotest Laboratories, Inc., Deer Park, N.Y.

David Fulton: Joined the staff of Rocket Power, Inc., Mesa, Ariz., as a senior engineer.

Paul D. Leeke: Appointed research projects manager at Mincom Div. of Minnesota Mining & Manufacturing Co., Los Angeles.

Harrison F. Edwards: Named Executive vice president of Simmonds Precision Products, Inc., Tarrytown, N.Y.

Col. Charles R. Graham: Named Project manager for the International Hawk/NATO Hawk Air Defense Missile System, Huntsville, Ala.

Joseph M. Verlander: Appointed chief engineer and director of engineering for Martin-Canaveral, Cocoa Beach, Fla.

James T. Stoms: Named director of Titan II flight test operations at Cape Canaveral for Martin-Canaveral, Cocoa Beach, Fla.

Ross D. Stevens: Named vice president-finance and treasurer of Electro Instruments, Inc., San Diego, Calif.

Daniel J. Rice: Appointed manager of underseas electronics marketing at Motorola Inc.'s Chicago Military Electronics Center.

Nicholas M. Voorhies: Named general manager of Martin Co. activities in Washington, D.C.

Sam Forman: Appointed manager of the Micro-Module Div. of National Resis-Tronics, Inc., Pearl River, N.Y.

Horace S. Herrick: Appointed manager of government sales-relations for the Erie Resistor Corp., Erie, Pa.

Peter L. Bealer: Appointed advertising and sales promotion manager of ITT General Controls Inc., Glendale, Calif.

Sidney Metzger: Appointed manager for components development and systems research for the Communications Satellite Corp., Washington, D.C. **S. H. Reiger** appointed manager for systems analysis, and **Edwin J. Istvan** named technical assistant to the president.

Charles E. Exley, Jr.: Elected controller of the Burroughs Corp., Detroit, Mich.

Joseph I. Heller: Joined the Telemet Co., Amityville, N.Y., as director of systems development.

David K. Wang: Appointed manage of a special air defense division at Aerojet General Corp.'s Solid Rocket Plant, Sacramento, Calif.

Algert G. Grimaila: Appointed associate director of engineering at Motorola Inc.'s Chicago Military Electronics Center

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—when and where—

JUNE

AIAA Summer Meeting, Ambassador Hotel, Los Angeles, June 17-20.

Electronic Industries Association Annual Convention, Pick-Congress Hotel, Chicago, June 17-20.

Institute of Electrical and Electronics Engineers, Summer General Meeting, Toronto, Canada, June 17-21.

American Nuclear Society Annual Meeting, Gatlinburg, Tenn., June 20-24.

American Institute of Electrical Engineers Summer General Meeting, Fountainebleau Hotel, Miami Beach, Fla., June 20-25.

Institute of Space Communications, sponsored by the University of Maryland with the cooperation of the Goddard Space Flight Center, University of Maryland, College Park, Md., June 23-28.

66th Annual Meeting, American Society for Testing and Materials, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., June 23-28.

Symposium on the Problems and Application of Dielectrics in Space, Westinghouse Research Laboratories, Pittsburgh, June 25-26.

AIAA First Annual Meeting and Exposition, Sheraton-Park Hotel, Washington, D.C., June 29-July 3.

JULY

Seventh National Conference on Aerospace Education, National Aerospace Education Council, Hotel Deauville, Miami Beach, Fla., July 7-11.

IEE 1963 International Symposium on Space Telecommunications, sponsored by Professional Technical Group on Antennas and Propogation, Boulder Laboratories, National Bureau of Standards, Boulder, Colo., July 9-11.

Meteorological Support for Aerospace Testing and Operation, sponsored by AIAA and American Meteorological Society, Ft. Collins, Colo., July 10-12.

National Association of Power Engineers, National Convention, Everglades Hotel, Miami, July 14-19.

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

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An American Tragedy

NO MAN is irreplaceable. But the loss of D. Brainerd Holmes as boss of the *Apollo* program for the National Aeronautics and Space Administration is a distinct setback to our lunar effort.

Less than two years ago, Brainerd Holmes came to NASA with high hopes and a desire to serve his country. The night his appointment was announced in September, 1961, we telephoned him long-distance to ask what he expected in his new job.

He said he thought the toughest part would be "integrating the vast numbers of people, industry and government agencies into one common effort as soon as possible."

He was wrong. It was a tough part of his job. But it wasn't the toughest. Holmes then was with Radio Corp. of America, where he had been responsible for coordinating the efforts of the military and some 2,900 firms on the BMEWS project. Coordination was no puzzle to him.

After his arrival in Washington, in a more formal interview, Holmes expanded on his management philosophy in a talk with our NASA editor, Hal Taylor. The new boss of the Moon program said then:

"I feel my job is to direct a program management group which will coordinate NASA resources for, control the budget for, and be responsible for all U.S. efforts to get a man in space."

Within that statement lie the seeds of Brainerd Holmes' discontent and the reason for his announcement last week that he is returning to private industry as soon as his job can be turned smoothly over to someone else.

In the first flush of enthusiasm after President Kennedy's announcement of the U.S. entry into the lunar race, the new *Apollo* boss had been told he would have all the authority he needed to get the job done. His superiors made it clear that this amounted to almost *carte blanche*.

To Holmes, authority meant more than just responsibility to do the job—it meant the money and the resources to do it. He thought he had this. But slowly over the long months which have followed, Brainerd Holmes has met with a series of frustrations.

He came to Washington with a true desire to serve his country and a belief that this service was worth a financial sacrifice. His $21,000 salary at NASA was considerably less than his RCA salary and considerably less than he would have made anywhere else in industry.

He came convinced that his country also was prepared to make the necessary financial sacrifices. He found over the months that this nation apparently is not willing to go all-out to beat the Russians to the Moon.

To keep the *Gemini* program on schedule, it was necessary last fall to seek a supplemental appropriation from Congress. The White House and the NASA Administrator overruled the head of the Office of Manned Space Flight. No supplemental would be requested. A slippage of some six months in *Gemini* was to be regarded as acceptable.

It is no secret that D. Brainerd Holmes was not happy about that decision. He had been given a job to do and now the first strings were being tied around his hands.

The information from *Gemini* is vital to *Apollo*. There are many unknowns in space. They must be discovered as quickly as possible so the knowledge can be applied to the designs for the *Apollo* mission. The first nation to find the unknowns will be the first nation to solve the design problems presented by them.

Yet, in the face of an all-out space effort by the Soviet Union, an effort already ahead of the U.S. by several years, a slippage of six months in *Gemini* was to be accepted.

Brainerd Holmes isn't the kind of man who wants to half-way try. Either you play to win or you don't play. But he swallowed his anger last fall and kept trying, still not happy with the knowledge that he could be saddled with a failure due to events over which he was to be given no control.

Then came the Fiscal 1964 budget. NASA prepared four budgets for submission to the Bureau of the Budget, at levels of $5.2 billion, $5.6 billion, $6.2 billion and $6.6 billion.

There is no question that both the $6.2- and $6.6-billion proposals would substantially have speeded the U.S. effort to reach the Moon. NASA Administrator Webb himself made that clear.

"Yes, we could have speeded it up," he said. "I say that categorically."

LAST WEEK, it became clear that even the $5.7-billion NASA budget sent to Congress by the Administration was running into trouble. The manned spaceflight subcommittee of the House Space Committee has hacked the *Apollo* budget by some 9-10% for Fiscal 1964. The full committee is expected to go along with this recommendation.

Once again, funding of the effort to beat the Soviets to the Moon is encountering reluctance which belies the full support promised to Brainerd Holmes when he took the job of Moon boss.

And in the other wing of Congress, the Senate Space Committee has been providing a forum for distinguished scientists who have derided the *Apollo* effort with assertions that the money would be better spent on cancer research or foreign aid.

The mood and the money have changed. Holmes has been left with the responsibility but not the authority. One can only sympathize with his decision to leave and hope that his leaving will jar a luxury-softened Administration, Congress and nation into a realization that the money to land on the Moon must be spent today, not the year before we get there.

William J. Coughlin

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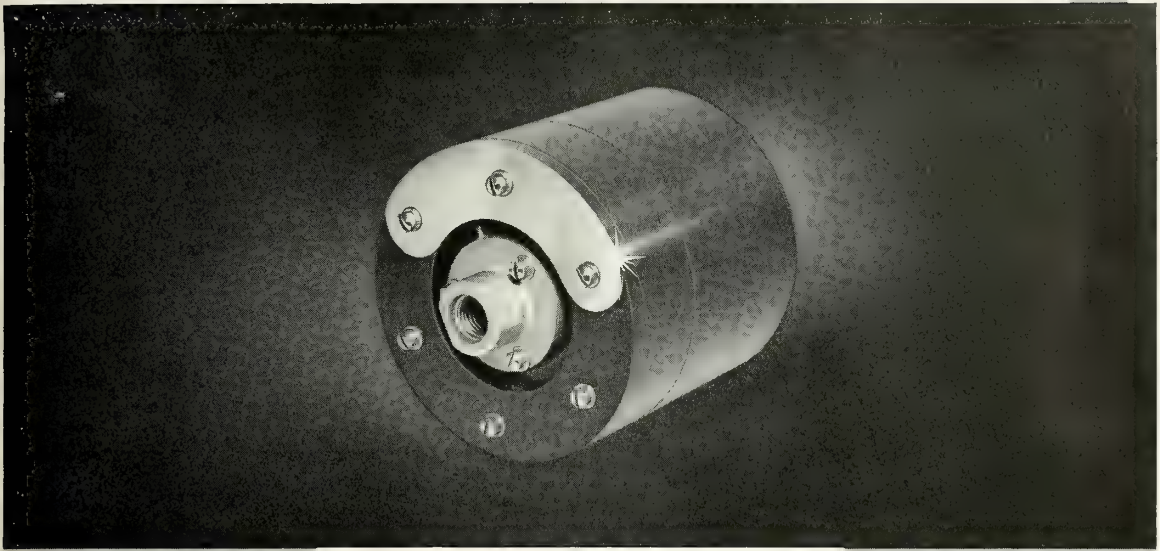

VERSATILITY

The unit above has been used as a rate-of-climb indicator, for the mass measurement of cryogenic fuels, and as the basic sensor in a roll-pitch-and-yaw controller.

The unit above is an airborne ΔP transducer by Trans-Sonics, Inc. Driven by unregulated 28 vdc, it produces a 0–5 vdc output over a minimum range of 0–30 mmHg.

It is a straightforward and versatile device.

Not all Trans-Sonics* devices are as versatile — we design and build most for specific needs. Our versatility comes in the technologies that we can, and do, bring to bear on a problem. Direct digital readout, parametric logic and amplification devices, and solid-state self-balancing bridges have all been employed in the design of Trans-Sonics' transducers and systems.

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When the ultrasonic F 104 G Starfighter takes off on a mission, it relies on EEMCO actuators for maneuverability as well as the job of opening and closing the camera system door. In any situation, under any stress, this electromechanical rotary actuator allows the Starfighter to make the necessary mission pictures — bombing, target practice, or reconnaissance. Starfighters are also equipped with EEMCO actuators for the leading edge slat and the trailing edge flap. For further information on EEMCO-developed state-of-the-art actuators, motors, and starter-generators for aerospace and industrial applications, write or call the EEMCO Division of Electronic Specialty Co. at the address shown below.

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REpublic 3-0151

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Actuator (Camera Door), Electro-Mechanical, Rotary Type D 1450 Degrees of rotation — 245 ±1 degree, Reversible, with brake and clutch, built in limit switches, R. N. filter ■ Mechanical end stops to limit maximum travel ■ Totally enclosed, explosion proof design ■ Normal operating load — 500 inch pounds ■ Current at 28 volts, dc — 3.9 amperes ■ Time — 5.0 seconds ■ Duty Cycle three complete cycles within one minute — off four minutes. Maximum operating load — 4,000 inch pounds (ice breaking load). Stall torque 5,100 inch pounds. Ultimate Static Load — 7,600 inch pounds. Qualified to Military Specifications MIL-A-8064A (USAF) and MIL-E-5272C (ASG). Weight 7.5 pounds.

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issiles and rockets

HE WEEKLY OF SPACE SYSTEMS ENGINEERING

HOUSTON
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turn Stage Goes Aboard 'Pregnant Guppy'

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F Debates Design of Manned Craft .

unar Logistics Development Delayed

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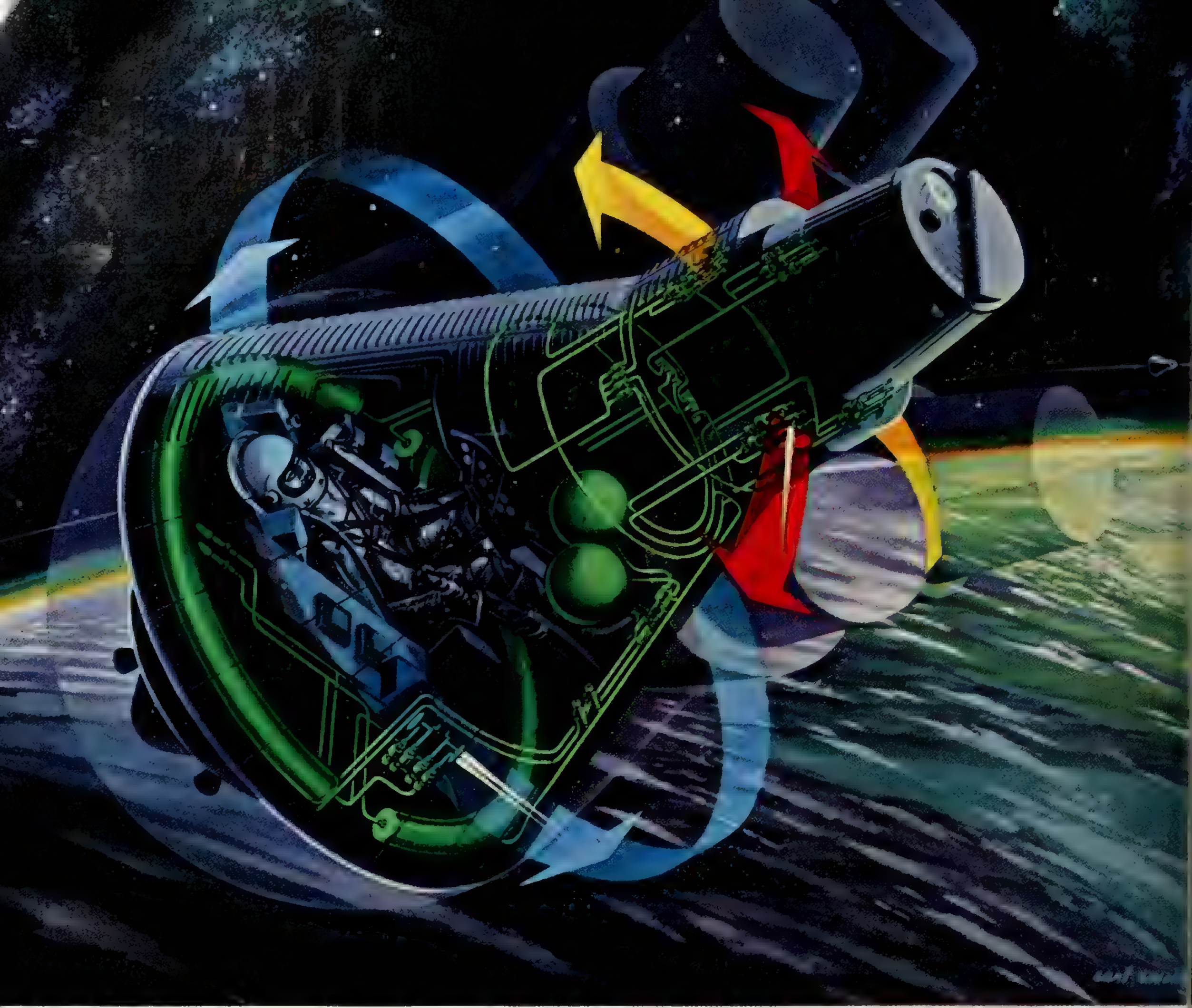

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Out in space, where conventional aerodynamic controls have no effect, Bell's "steam steering" reaction control system provides Mercury astronauts with complete pitch (yellow arrow), yaw (red arrow) and roll (blue arrow) control. Eighteen tiny rockets are used to provide thrust with which the astronaut positions NASA's McDonnell built spacecraft while in orbit. Thrust is obtained by steam, created when hydrogen peroxide passes over the silver screen catalyst in each rocket motor.

The unique reaction control system not only serves as the astronaut's "steering gear" in space, it is also used to position the spacecraft into precise attitude for re-entering th earth's atmosphere.

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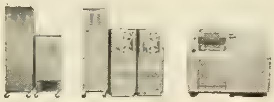
canoga

Combining radar tracking and telemetry techniques with advanced digital technology, Canoga has designed, for the U.S. Navy, a computer-based tracking data acquisition system now in operation at Patuxent River Naval Air Station, Md. The system, which tracks multiple targets simultaneously, includes Canoga's AN/MPS-26 radar, digitized cinetheodolites, microwave data links and a digital computer. Canoga was responsible for the installation and programming of the entire system. The computer output correlates trajectory information, target performance data and range time. This tracking system is typical of Canoga's ground, mobile and shipborne experience, which includes equipment for all the major missile ranges, with particularly significant contributions to Projects Mercury, Gemini and Glotrac. Write for details.



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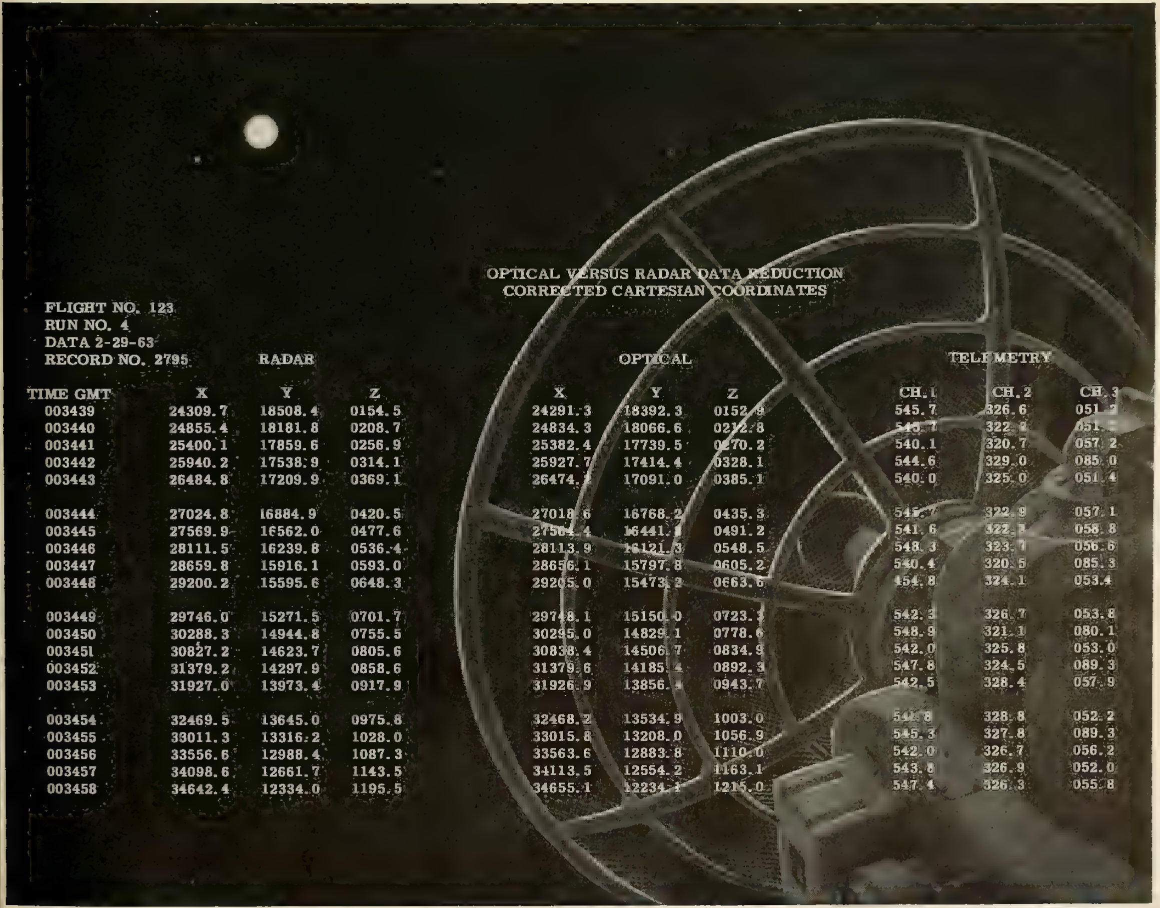

OPTICAL VERSUS RADAR DATA REDUCTION
CORRECTED CARTESIAN COORDINATES

FLIGHT NO. 123
RUN NO. 4
DATA 2-29-63
RECORD NO. 2795

	RADAR			OPTICAL			TELEMETRY		
TIME GMT	X	Y	Z	X	Y	Z	CH. 1	CH. 2	CH. 3
003439	24309.7	18508.4	0154.5	24291.3	18392.3	0152.9	545.7	326.6	051.[illegible]
003440	24855.4	18181.8	0208.7	24834.3	18066.6	0212.8	545.7	322.2	[illegible]
003441	25400.1	17859.6	0256.9	25382.4	17739.5	0270.2	540.1	320.7	057.2
003442	25940.2	17538.9	0314.1	25927.7	17414.4	0328.1	544.6	329.0	085.0
003443	26484.8	17209.9	0369.1	26474.2	17091.0	0385.1	540.0	325.0	051.4
003444	27024.8	16884.9	0420.5	27018.6	16768.2	0435.3	545.7	322.9	057.1
003445	27569.9	16562.0	0477.6	27564.4	16441.[illegible]	0491.2	541.6	322.[illegible]	058.8
003446	28111.5	16239.8	0536.4	28113.9	16121.3	0548.5	548.3	323.7	056.6
003447	28659.8	15916.1	0593.0	28656.1	15797.8	0605.2	540.4	320.5	085.3
003448	29200.2	15595.6	0648.3	29205.0	15473.2	0663.6	454.8	324.1	053.4
003449	29746.0	15271.5	0701.7	29748.1	15150.0	0723.[illegible]	542.3	326.7	053.8
003450	30288.3	14944.8	0755.5	30295.0	14829.1	0778.6	548.9	321.1	080.1
003451	30827.2	14623.7	0805.6	30838.4	14506.7	0834.9	542.0	325.8	053.0
003452	31379.2	14297.9	0858.6	31379.6	14185.4	0892.3	547.8	324.5	089.3
003453	31927.0	13973.4	0917.9	31926.9	13856.4	0943.7	542.5	328.4	057.9
003454	32469.5	13645.0	0975.8	32468.2	13534.9	1003.0	541.8	328.8	052.2
003455	33011.3	13316.2	1028.0	33015.8	13208.0	1056.9	545.3	327.8	089.3
003456	33556.6	12988.4	1087.3	33563.6	12883.8	1110.0	542.0	326.7	056.2
003457	34098.6	12661.7	1143.5	34113.5	12554.2	1163.1	543.8	326.9	052.0
003458	34642.4	12334.0	1195.5	34655.1	12234.1	1215.0	547.4	326.3	055.8

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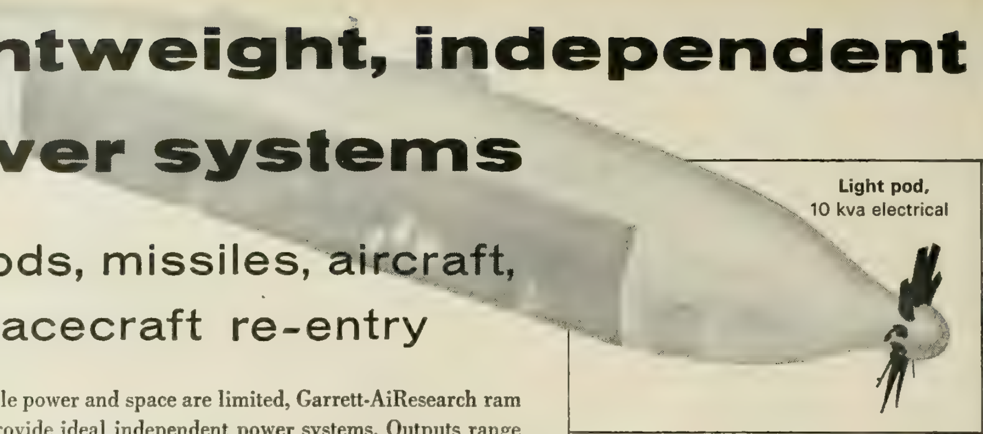
Lightweight, independent power systems

for pods, missiles, aircraft, spacecraft re-entry



Light pod,
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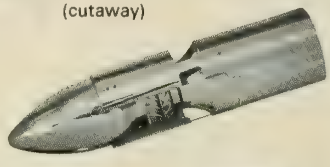
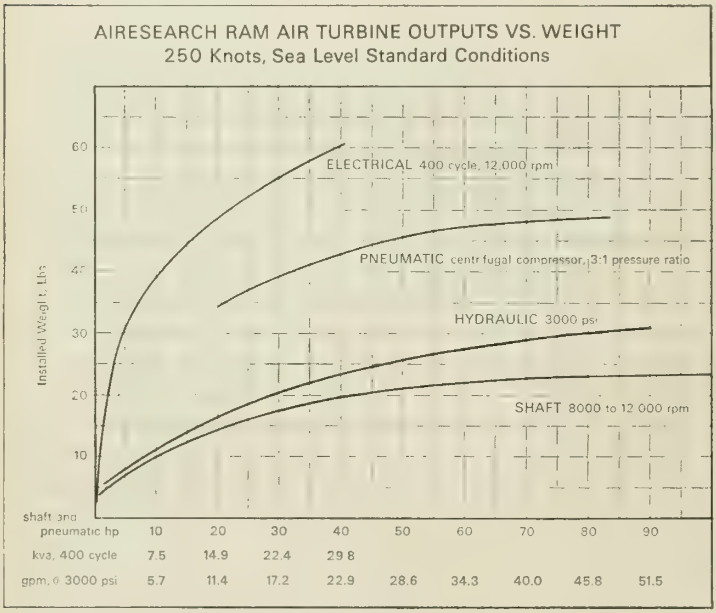
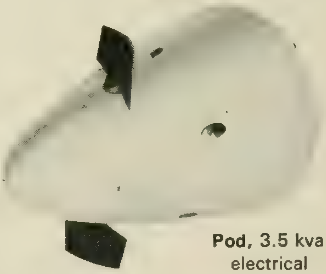
Missile, 225 watts, 6000 cps electrical
(cutaway)



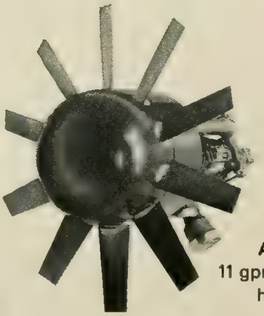


AIRESEARCH RAM AIR TURBINE OUTPUTS VS. WEIGHT
250 Knots, Sea Level Standard Conditions
Installed Weight, Lbs
60
50
40
30
20
10
ELECTRICAL 400 cycle, 12,000 rpm
PNEUMATIC centrifugal compressor, 3:1 pressure ratio
HYDRAULIC 3000 psi
SHAFT 8000 to 12 000 rpm
shaft and pneumatic hp 10 20 30 40 50 60 70 80 90
kva, 400 cycle 7.5 14.9 22.4 29.8
gpm, @ 3000 psi 5.7 11.4 17.2 22.9 28.6 34.3 40.0 45.8 51.5

Pod, 5 shp
shaft output



Pod, 3.5 kva
electrical



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missiles and rockets

Volume 12, Number 25 June 24, 1963

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THE COVER

Inert Saturn I S-IV stage, largest cargo ever airlifted, goes aboard modified Boeing Stratocruiser for test flight from Los Angeles to Edwards AFB. If the B-377 PG ("Pregnant Guppy") gets FAA certification, it may carry huge Douglas-built booster stages to Cape Canaveral.

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46,033 copies this issue

† U.S. Reg. Pdg.

Ethics and Astronauts

To the Editor:

Speaking as a private individual, I must say that your June 10 editorial ("Further on Ethics") was sickening as well as being an unnecessary comment on a subject which has already been beaten to death. In view of the usual and continuing fine quality of your magazine, I was quite shocked at your comments.

William J. English
Field Operations Manager
Telemetering Corp. of America
Van Nuys, Calif.

To the Editor:

I would like to congratulate you on what I consider to be a fine piece of editorial writing in the June 10 M/R. I wholeheartedly agree with all the points that you brought forth. The stigma of commercialism will do much to thwart the determined activities of many individuals in our manned space effort.

Glen Stevens
Aerospace Research Analyst
Dean Witter & Co.
Los Angeles

To the Editor:

I am surprised to find your magazine editorializing on the subjective interests of the astronauts instead of the objective interests of your readers. I am sure, sirs, that you are not averse to deriving economic benefits from your business endeavors! Thus, I fail to see why you object to the astronauts deriving personal security for their families. The success, to date, of all *Mercury* flights in which the astronauts were directly involved seems to indicate their performance has been one of dedication.

O. G. O'Brien
Upland, Calif.

Civil Defense Shelters

To the Editor:

The statement by Defense Secretary McNamara (M/R, June 10, p. 9) that shelters are a must for anti-ICBM defense deserves careful consideration by those who are opposed to fallout shelters for one reason or another. Our present civil defense and its shelters are woefully inadequate, to say the least.

The U.S. Government Printing Office publishes a great deal of material on civil defense and related subjects. Much of this material is described in the free price-list, *PL 84-Atomic Energy and Civil Defense,* that may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for the asking.

D. W. Johnston
Washington, D. C.

At Bat for Apollo

To the Editor:

In his "Doubts about Apollo" letter (M/R May 27, p. 7), K. G. Hagen has taken M/R to task for its defense of the *Apollo* program. He is quite ready to question the judgment of M/R—a magazine whose existence depends upon intimate detailed knowledge of our space program—and then proceeds to cast a series of judgments of his own through unsupported statements, unwarranted analogies, and a number of loose generalizations.

Item: Anyone can judge the value of a publicity stunt, one aspect of *Apollo's* purpose.

Presumably, success in landing Americans on the Moon and bringing them home safely is categorized as a stunt by Mr. Hagen. The thought that this procedure is a major step in exploring the solar system, that it can be translated quite directly to economic gain by virtue of the prestige and world leadership demonstrated therein has not occurred to him.

If Hagen had witnessed the Wright Brothers' Kitty Hawk Project, would he have called it a publicity stunt, too? Of what practical value was an aircraft that flew only 120 feet? Was technology ready for aeronautics? Or in fact did the successful demonstration provide a tremendous boost to the technology of the times!

Item: . . . "hard-headed practical" engineer cannot . . . endorse a project with such a poor ratio of utility to expenditure.

Here is prejudgment at its worst. Any engineer associated with the *Apollo* program (and *any* engineer who makes any attempt at all to keep up with the commensurate literature) would be completely aware of:

a. Advances made in that program in electronics quite applicable to television as used in the home and to aircraft and worldwide communications.

b. Materials research in metallurgy, plastics and ceramics which have led and will lead to such mundane and *practical* items as improved utensils in the kitchens of millions of homes. Does Hagen recall the Corning ceramic pyroceram derived from ablation studies for missiles and now used for ovenware in so many American homes?

c. Advances in medical instrumentation such as the biopacks which will permit the condition of a hospital patient to be determined remotely, thus allowing one nurse to care for many patients simultaneously and therefore cutting the cost of such care.

d. Improvements in packaging techniques for instrumentation aboard the spacecraft. This leads to modularization in an optimum manner so that faulty portions of a system can be replaced quickly and with relative ease. This methodology obviously can be used throughout the U.S. economy, and the advantages in reduced time and costs for maintenance and repairs are very evident.

Item: We cannot tolerate errors in orbital flight . . . *Apollo* depends on perfect execution of techniques . . .

The prescient Mr. Hagen is rather convinced that our (U.S.) efforts at orbital rendezvous and other procedures for completion of the *Apollo* project are going to be inadequate, and consequently *Apollo* will be less than successful. An analogy is drawn to the previous failures to conquer Mt. Everest because of the lagging technology, and therefore the deficiency of equipment then available. Our foreboding fellow apparently does not read the literature very well, nor is he familiar with the research, care, and precision going into every system to go aboard or support the *Apollo* spacecraft. His analogy has no basis in fact. What is more, his generalization about our inability to tolerate errors is wide of the mark. Errors have crept into many space endeavours—they do not keep us from success. Has Hagen ever heard of Glenn, Carpenter or Cooper, and their experiences in orbit?

Item: The prejudgment of scientific worth and results by some members of the scientific community of the *Apollo* program appeals to results-oriented Mr. Hagen.

Apparently, he too, thinks that man can be replaced by a machine. All the hypotheses about the condition of the lunar surface proposed since the Moon was first observed will be largely settled in the first few hours after man lands on that surface. No computer presently existing or contemplated has or is likely to have in our lifetime the capability in pattern recognition, in reasoning, in discernment, in diagnoses and prognoses which man has.

Rather than wait until 1980-1990 to accomplish the *Apollo* tasks, as suggested (seriously?) by Hagen, the success that was *Apollo* long before that era will most assuredly have led to successful landings on and exploration of the planet Mars by quite a few Earthlings during the years 1980-1990.

Item: The main reason it (*Apollo*) is regarded as essential is . . . occupant of White House . . . stated it as a National Goal.

The competence of the White House in engineering and science, Mr. Hagen, is reflected in a Presidential advisory committee of scientists and engineers chosen from the top talent in this country. The American public in a very non-partisan fashion has expressed its consolidated opinion that we—the U.S.A.—should be first in space. Our elected representatives in Congress certainly have so agreed. The President is our chief representative in that endeavour. He expresses the wish of the majority.

Lastly, the analogy with the adventurous, somewhat haphazard wanderings of Lief Ericsson is unadulterated nonsense. The *Apollo* program constitutes a series of tasks precisely delineated that are being prepared with wisdom and care—far more care than Hagen has given to his analyses.

Saunders B. Kramer
Sunnyvale, Calif.

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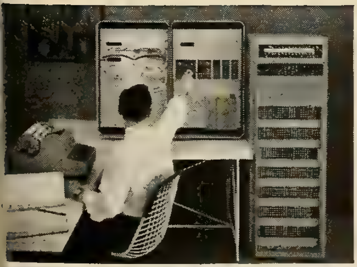

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The Countdown

WASHINGTON

NASA Wants Industry Man to Replace Holmes

Top NASA officials report that no present space agency official is being considered as a replacement for D. Brainerd Holmes as director of the Office of Manned Space Flight. They commented after speculation that either George M. Low, deputy director of the office, or Manned Spacecraft Center director Robert Gilruth might be picked for the job. Officials say they want a man from industry with management experience. NASA's first choice—Dr. Ruben F. Mettler, executive vice president of Space Technology Laboratories—is not interested in the position for personal reasons. He is expected, however, to come to Washington for discussions this week.

NASA To Buy Atlas-Agenas

A NASA-DOD agreement giving NASA authority to purchase its own *Atlas-Agena* launch vehicles is imminent. NASA has signed it and Pentagon approval is expected shortly.

enate Group Winds up Budget Hearings

Senate Space Committee last week completed public hearings on NASA's Fiscal '64 budget request and suspended further action until the bill clears the House. Sen. Howard Cannon (D-Nev.) has asked NASA to furnish the committee with a list of $500-million worth of items which could be cut from the budget with the least effect on U.S. space goals. Since the list will be part of the public record, it could mean that this year the Senate may not play its traditional role—may not restore 50% of the funds cut by the House. However, nearly all of the scientific witnesses the committee called during its hearings strongly endorsed the lunar program.

GE About to Sign Apollo Contract

NASA and General Electric have just about completed negotiating the contract for systems integration in Project *Apollo*. NASA says the contract signing is imminent. Signing was delayed by such problems as relocation of GE employees—not the hardware exclusion clause that prohibits the firm from participating in related *Apollo* systems production.

Studies Planned During Eclipse

The total solar eclipse on July 20 will signal considerable activity for NASA scientists and organizations working under NASA contract. A space agency team will go to Maine to attempt photographic location of faint comets traveling near the Sun. Scientists from Geophysics Corp. of America, under NASA contract, will conduct a series of seven two-stage *Nike-Apache* sounding rocket firings, six of them during the 2-hr. 12-min. eclipse period, to note effect of a short period of solar radiation intensity change upon molecular particles and temperatures in the upper atmosphere. Probes will be launched from Ft. Churchill, Canada. A Johns Hopkins Univ. team will instrument two *Aerobee* sounding rockets to measure UV and particle behavior, also under NASA contract.

AD Decision at Hand

NASA is expected to decide in about three weeks whether to proceed with development and purchase of the *Thrust-Augmented Delta* (*TAD*). Modified Douglas space booster uses three strap-on solid rockets to increase first-stage thrust to the 330,000-lb. level, doubling payload capacity of the three-stage *Delta*. If the decision is in favor of *TAD*, the space agency probably will acquire complexes 26 and 56 at Cape Canaveral for use in the unmanned space vehicle program.

Signs of the Times

With the *Mercury* program dead less than one week, sign painters have blocked out the name "Mercury Control" at Cape Canaveral and substituted "Mission Control Center."

INDUSTRY

Nuclear Fusion Rocket Nearer

If controlled nuclear fusion can be achieved in a hot, stable plasma, say Aerojet-General/Nucleonics engineers, no unsolved fundamental problems will remain in the way of developing a fusion rocket for space. However, a very tough engineering problem will still have to be met. A-G/N bases this qualified optimism on its successful demonstration of superconduction alloys. Coils of vanadium-gallium alloy at cryogenic temperatures would be capable of producing the magnetic field needed to contain the intensely hot, reacting plasma. Engineering problem is to maintain cryogenic temperatures in spite of neutronic heating.

RCA Wins Contract, Expects LEM Job

RCA has been selected by the Goddard Space Flight Center to operate and maintain two new satellite data acquisition facilities near Rosman, N.C., and Fairbanks, Alaska. The $5-million award will cover two years. RCA has also been chosen by Grumman Aircraft Engineering Corp. for systems engineering work on the Lunar Excursion Module (LEM) program. NASA approval of the contract—which may be worth up to $20 million—is expected in the near future.

Stride in Solar Space Power

A solar concentrator for space power systems weighing 80 to 90% less than collapsible parabolic dishes is possible with a new folded optical geometry being explored by Goodyear Aircraft Co. The cone-and-column system requires a 10% greater diameter to compensate for losses due to the fact that incoming energy is reflected three times before reaching the focal point, rather than once. But the structural advantages more than offset this.

INTERNATIONAL

CARDE Gets a New Boss

Dr. Leon J. J. L'Heureux has been appointed Chief Superintendent of the Canadian Armament Research and Development Establishment at Valcartier, Quebec. CARDE does major share of all solid-propellant development in Canada.

First German Sergeant Group Ready

The first battalion of Sperry *Sergeant* tactical missiles to be formed by the West Germany armed forces has been activated in Northern Germany. Two more battalions will be added later under the present contract with the U.S.

Ford Studies Martian 'Taxi'

A Martian "taxi" to ferry U.S. astronauts between an orbiting spaceship and the surface of the planet Mars will be investigated by Ford Motor Co. scientists under a $99,512 NASA contract. Ford's Aeronutronic Div. will conduct the study of the Mars Excursion Module (MEM), a vehicle carried by a larger spacecraft. It would be designed to taxi astronauts between the larger vehicle and Mars, around which the larger spacecraft would be orbiting.

In a Mars mission, perhaps in the middle of the next decade, such a vehicle could land several astronauts on the planet for exploration, possibly remaining there for as long as 40 days before returning to the mother spacecraft for the return voyage to Earth.

Aspects being studied include trajectories, weights and preliminary design, rendezvous, propulsion requirements, life-support systems, Martian atmospheric entry, Mars surface operations, long lead-time requirements, funding requirements, and other critical factors.

Shots of the Week

Russia lofted the first woman into space June 16 after orbiting Soviet Air Force Lt. Col. Valery F. Bykovsky on June 14. "Cosmonette" Lt. Valentina V. Tereshkova made the historic trip. (See p. 14.)

Other shots of the week:

- NASA's seventh *Tiros* weather satellite was boosted into orbit from Cape Canaveral June 19 by a *Delta* launch vehicle. Purpose of the Earth-orbiting "weather eye" satellite is to seek out and relay storm tracking data to Earth.

Early reduction of data indicated *Tiros VII* was in an orbit with apogee of 404 miles and perigee of 384 miles. Inclination was 58 degrees, and period, 97 minutes.

Representatives of Goddard Space Flight Center said *Tiros VII* quickly began sending back excellent pictures of cloud cover and a large amount of data from several scientific experiments carried on the satellite.

In a post-launch conference, William G. Stroud, chief of aeronomy and meteorology division at Goddard, said the *Tiros* program will continue through at least another eight spacecraft, including two "wheel" satellites (M/R, June 3, p. 17).

- On June 14 the Dept. of Defense announced a successful *Nike-Zeus* intercept of a "recent" Air Force *Atlas* ICBM (*Atlas* shots were made from Vandenberg AFB, Calif., June 2 and 12) in the Southwest Pacific. The *Nike-Zeus* was fired from Kwajalein Island. Intercept was the sixth such success announced by DOD.
- A June 12 *Atlas-Agena* launch attempt from Point Arguello, Calif., exploded shortly after launch. Payload was not revealed.
- An Air Force *Blue Scout*, bearing an undisclosed payload, was launched June 15 from Point Arguello, Calif.
- The Navy's *Polaris A3* was fired June 17 from the USS Observation Island, a laboratory test ship. Shot was said to be the first success at sea. The nuclear sub, USS Lafayette launched two *Polaris A2* missiles June 13 while cruising 75 ft. below the surface of the Atlantic some 25 miles off Cape Canaveral. Both launches were termed successful, but the Navy revealed no flight details.
- NASA's *X-15* rocket plane reached a maximum of 223,000 ft. altitude and a maximum speed of 3,477 mph (at 132,000 ft. alt.) June 18 in a 10-minute flight from Edwards AFB, Calif. Pilot, Air Force Maj. R. A. Rushworth, put the ship into a series of three 5-degree yaws to measure air pressure and local air flow against the plane's tail surfaces. Flight was termed a success.
- A Strategic Air Command crew launched a *Minuteman* ICBM June 18 from Vandenberg AFB, Calif. Shot was the first made under fully simulated combat conditions.

Pershing Goes to Panama

The U.S. Army has sent an inert *Pershing* missile to Fort Sherman, Panama Canal Zone, for environmental testing under tropical conditions.

The missile was loaded on the Army Ship Lt. Col. John U. D. Page which sailed from Port Canaveral June 11. The Page is designed for shallow draft operation and has a bow ramp for use in over-the-beach test landings.

Antenna Delivered Just Four Months After Contract Award

SATELLITE COMMAND Antenna, first of four new multi-element high-gain arrays built by Radiation Systems, Inc., was tested and accepted last week by Goddard Space Flight Center less than four months after award of the $185,000 contract. Operating in the 120-155 mc range, the 7.5-kw antenna provides 24 db gain at 150 mc. The 2,450-lb. array measures 32 x 32 x 25 ft. overall. Ultimately, the nine-element antennas will be slaved to tracking antennas in NASA's Satellite Network at Fairbanks, Alaska, Rosman, N.C., Quito, Equador, and Johannesburg, S. Africa. (See also M/R March 11, p. 37).

This is a continuation of environmental testing for the *Pershing*, which underwent a series of tests last winter in the extreme cold of Alaska.

The Canal Zone tests will be conducted by technicians from the *Pershing* Project Office, Army Missile Command, Huntsville, Ala., and from Martin-Orlando where the missile was designed and manufactured.

Contractor Evaluation Set

NASA Deputy General Counsel Walter D. Sohier has told a House military operations subcommittee that a guide to "establish a set system of source evaluation" will soon be issued by the Department of Defense. NASA plans to use the guidelines, developed from DOD and NASA investigations into current source evaluation methods, "on a test case basis."

Main purpose of the plan, Sohier said, is to "improve the memory of the government regarding industry performance." Source evaluation boards will dip into a "central data bag," containing recorded performance reports on companies, before recommending a concern for a government contract. The reports will be compiled on completion of a contract and will be, essentially, an assessment by the project officer of the company's performance. Cost, timing and technical performance will be important factors in the final evaluation.

Companies will be shown the government's compressed assessment of their performance. Company observations will be recorded and considered in any subsequent evaluation.

NASA Director of Administration John D. Young pointed out that under existing arrangements unsuccessful bidders in contract competitions are not told why they lost unless the information is sought.

Space Accord Spelled Out

Agreement between the U.S. and the Soviet Union on several areas of pace cooperation appears imminent, Dr. Hugh L. Dryden, deputy NASA dministrator disclosed last week.

The general lines for such an greement had been drawn this past vinter in Rome in conversations beween Dryden and top Russian negoiator, Academician Anatoly Blagonavov (M/R, April 1, p. 18).

Details of the agreement presumbly were ironed out in a Geneva neeting held late last month between epresentatives of the two countries. hief U.S. negotiator Dryden said

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final agreement on their recommendations will be reached when the Soviet Academy of Sciences and the U.S. State Department approve the joint findings.

Dryden was speaking at the first annual international meeting of the National Capital Section of the American Institute of Aeronautics and Astronautics. He was awarded the chapter's first Von Karman Memorial Citation for his outstanding contributions to international cooperation in aeronautics and astronautics.

The NASA official listed the following areas of agreement between the U.S. and the Soviet:

—Starting in 1964, the two countries would exchange cloud pictures taken by weather satellites. Each country would have at least one such satellite in orbit at all times and the photographs would be exchanged within a few hours after they're procured.

—A "cold line" would be set up between the U.S. weather station in Suitland, Md., and a similar station in Moscow for two-way communications of cloud pictures and other weather data. Under the auspices of the World Meteorological Organization, other countries could participate in this exchange of data provided they paid their proportionate cost for the "cold line."

—Cooperative communication satellite experiments would be initiated starting with the *Echo II* satellite to be launched later this year. Because the satellite will not be visable simultaneously by the U.S. and Russia, the Jodrell Bank station near Manchester, England, will be used as an intermediate receptor.

—Both countries would attempt to integrate their magnetic field data obtained by satellites during the International Years of the Quiet Sun and come up with a unified single magnetic map of the world.

Saturn Complex Award Made

R. E. Clarson, Inc., St. Petersburg, Fla., has won a $1,810,937.90 contract from the Army Corps of Engineers' Cape Canaveral District for construction on the *Saturn V* Complex 39 facilities at the Merritt Island Launch Area.

The contract calls for construction of concrete foundations for umbilical towers that will be installed later under another contract.

Clarson's contract also includes crawlerway paving, building a concrete bulkhead waterfront area for unloading rocket components, and construction of a small pre-fabricated office building.

The launch-pad foundation work must be completed by Oct. 1, 1963, and the remaining work by Jan. 1, 1964.

Gemini Support Contract Let

The Canaveral District of the Army Corps of Engineers has awarded a $94,984.80 contract to an Orlando, Fla., firm to install a water-spray system at *Gemini* Complex 19, Cape Canaveral.

Orlando Welding and Piping Contractors will install the system, which will be able to deluge the 360,000-sq.-ft. complex with 8,000 gallons of water a minute. The fixed-type nozzles will be fed by water from a 36-in.-dia. main.

The contract calls for completion of the work within 90 calendar days.

Brown Defends MMRBM

Department of Defense Director of Research and Engineering, Dr. Harold Brown, has indicated there is a good possibility DOD will decide to go ahead with full-scale development of the *Mobile Medium Range Ballistic Missile* program.

Appearing before the House Subcommittee on Military Appropriations in defense of the *MMRBM* program, Brown deplored suggestions that the $143-million *MMRBM* budget request for FY '64 be cut. He indicated the *MMRBM* is a concept the U.S. is prepared to develop for its own weapons inventory, rejecting the suggestion that an R&D decision is being held up by delays among NATO countries that have shown interest in the system.

In view of Air Force suggestions that some FY '63 carry-over *MMRBM* money might be used for modification and upgrading of the performance and reliability of several Air Force missiles, a committee member asked if it was intended that FY '63 and '64 money be used for a "slush fund" for missiles. Such intent was denied by Maj. Gen. Robert J. Friedman, Air Force director of aerospace programs. Brown's remarks about *MMRBM* were interpreted as evidence that the concept may blossom into full-scale development at an early date—particularly in view of his statement that Secretary McNamara "is quite strong for this program."

In the area of medium altitude communications, however, Brown, advocated a reduction in funds that would permit only a minimal prototype system in 1965.

Immediate openings in:

AEROBALLISTICS

Aerothermo Mechanics (aerodynamic testing, analysis, stability and air loads; heat-transfer studies; thermodynamics of power systems and cryogenic storage; aerothermo research in theoretical gas dynamics, radiation physics, and computer programs.) Flight Mechanics (trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics and celestial mechanics.)

FUTURE SYSTEMS ANALYSIS

Mission analysis and planning operations research, advanced program planning, human factors.

ELECTRICAL and ELECTRONICS

Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES

Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

MANUFACTURING

Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

PROGRAMMERS

Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

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Perhaps in August . . .

More Cosmonaut Trips Expected

Vostok V & VI flights smash old orbital records, but U.S. officials believe Russians had hoped for longer trip, rendezvous

U.S. OFFICIALS expect the Soviet Union to make more manned space flights this year in the wake of the spectacular, but somewhat disappointing, twin flights of Lt. Col. Valery Bykovsky and the world's first female astronaut, Lt. Valentina Tereshkova.

The Soviet space fliers were recovered successfully on June 19 following flights of five and three days respectively. Bykovsky in *Vostok V* set a new world's record for manned spaceflight when he orbited the Earth 82 times—almost one day longer than the previous record 64-orbit flight by Soviet Cosmonaut Andrian Nikolayev in August, 1962.

Miss Tereshkova's flight lasted for 49 orbits, far surpassing the total length of all three previous U.S. manned space missions.

A top White House official told MISSILES AND ROCKETS that "while the flight was a significant achievement, it fell short of what the U.S. expected and the Soviet Union had planned."

Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, said he believed the Russians had intended "either an eight-day flight, rendezvous and docking, or both."

He predicted more Soviet manned space shots this year. He indicated that the missions would include further long-duration flights and rendezvous attempts, as well as a possible experimental flight of a new two-man Soviet spacecraft.

- **Nearest to rendezvous**—Col. Bykovsky was launched at 8:00 a.m. EDT on June 14, from the Baikonour space center in the central Asian Republic of Kazakhstan. He landed safely at 7:06 a.m. EDT on June 19 330 miles northwest of Karaganda, Kazakhstan. During his flight of slightly over 119 hours, he and the *Vostok V* spacecraft traveled more than 2 million miles.

Junior Lt. Tereshkova was launched at 5.30 a.m. EDT on June 16, in the *Vostok VI* spacecraft. She also landed safely at 4:20 a.m. EDT 330 miles southeast of Karaganda. During her flight of 71 orbits, she traveled more than 1,240,000 miles through space.

In addition to the record duration and the orbiting of the first female space pilot, the twin Soviet flight also marked the closest two piloted vehicles have come to each other in space.

It was reported that *Vostok VI* came within three miles of *Vostok V* during the first orbit of Miss Tereshkova. This was about a mile closer than the two previous Russian space twins—Lt. Col. Pavel Popovich and Maj. Andrian Nikolayev—came to each other on Aug. 12, 1962.

Major changes in the flight plan, compared to that of the earlier twin flight, and technical problems prevented any rendezvous attempt or an eight-day flight for the two latest *Vostoks*.

- **Power loss**—Because of an apparent loss of booster thrust, the orbit of *Vostok V* was not as high as the Russians had planned, U.S. officials said.

On June 14, NASA reported that *Vostok V* was orbiting the Earth every 88.16 minutes with an apogee of 130.13 statute miles and a perigee of 108.87 statute miles.

Officials declared that this was not high enough to sustain an eight-day orbital flight. They predicted the 10,000-lb. spacecraft would continue to fall closer to Earth and that the flight would have to be terminated prematurely.

This apparently did occur. On June 15, *Vostok V's* perigee was 105.45 miles, on June 16, 104.78 miles, and by June 18 it had dropped to 91.69 miles, where Earth's atmosphere began to slow its speed. It landed on June 19.

In comparison, *Vostok VI*, according to NASA announcement on June 16, was orbiting the Earth every 88.32 min., with an apogee of 133.98 miles and a perigee of 108.93 miles. On June 17, its orbital period was 88.18 min., with an apogee of 129.58 miles and a perigee of 107.38 miles.

- **Launch gap**—The recent flight also lacked the split-second launch timing chalked up by Soviet scientists in the first twin flight, when the two cosmonauts were launched within almost exactly one day of each other.

Instead, Miss Tereshkova was launched 45½ hours after Col. Bykovsky.

The inability to launch both spacecraft at almost the same time—although on different days—resulted in the large separation between the two landing areas and a difference in orbital path of 30 degrees from the equator.

In effect, this would put the two vehicles some 2,000 miles apart if they crossed the equator at the same time. It would also mean that if the spacecraft crossed at the northernmost and southernmost extremities of the orbit, the crossing angle would be a sharp 30 degrees.

In order to rendezvous, tremendous amounts of fuel would have to be carried on the spacecraft in order to perform a dog-leg maneuver to get one on to the orbital path of the other.

For example, U.S. project *Gemini* officials believe the *Gemini* and its *Agena* target vehicle will have to have orbital planes which will cross the equator within ½ degree of each other if a successful rendezvous is to be achieved.

There were also reports within U.S. Government circles that the Soviets had actually planned to launch a third cosmonaut in an orbit much closer to Col. Bykovsky so that a rendezvous could be made. This reportedly was scrubbed for some unknown reasons.

- **Bill of health**—The Soviet Union's initial communique said the flights were being made "to study various space flight factors on the human organism, including the comparative analysis of the impact of these factors on the organisms of a man and woman, to carry out new medical biological re-

COSMONAUT Valery Bykovsky.

COSMONAUT Valentina Tereshkova.

search and to further improve and perfect the systems of piloted spaceships in conditions of simultaneous flight."

After the pilots had safely landed, the Russians reported, they were both in excellent condition and suffering no adverse effects from the long period of weightlessness.

Miss Tereshkova may eventually force a change in the requirements for U.S. astronauts. The 26-year-old woman is the first person to make an orbital flight who has not had training as a pilot. Her only previous aeronautical experience was as an active parachutist.

In commenting on the Russian flight, Dr. Hugh L. Dryden, Deputy NASA Administrator, said that "the flight of *Vostok V* permitted the Soviet Union to extend the time in orbit by almost one full day. The use of the woman enabled them to compare data between men and women. There was no attempt at rendezvous."

Dr. Eugene B. Konecci, Director of NASA's Office of Biotechnology, declared that the Russians put "cosmonette" Valentina Tereshkova in orbit as part of a well-planned long-range program to establish colonies in space.

Konecci said Soviet space scientists have indicated to him that they plan to establish bases on the Moon and explore the nearby planets.

The scientist said, however, that Valentina's flight was of more immediate significance.

"What better way," he asked, "to get non-trained scientists to go up than to show it can be done by a woman?"

The *Vostoks* can keep their occupants alive for 10 or 12 days, according to the latest Soviet claims, he said.

He predicted further Soviet biomedical experiments in orbit as early as August.

- **Boxscore**—A list of manned space flights to date:

April 12, 1961, USSR, Maj. Yuri Gagarin, one orbit, 108 min.

May 5, 1961, U.S., Comdr. Alan B. Shepard, Jr., suborbital, 302 miles.

July 21, 1961, U.S., Capt. Virgil I. Grissom, suborbital, 302 miles.

Aug. 6, 1961, USSR, Maj. Gherman S. Titov, 17 orbits, 25 hours.

Feb. 20, 1962, U.S., Lt. Col. John H. Glenn, Jr., three orbits, nearly five hrs.

May 24, 1962, U.S., Lt. Comdr. Scott Carpenter, 3 orbits, nearly five hrs.

Aug. 11, 1962, USSR, Maj. Andrian Nikolayev, 64 orbits, 94 hrs. 35 min.

Aug. 12, 1962, USSR, Lieut. Col. Pavel Popovich, 48 orbits, 70 hrs. 57 min.

Oct. 3, 1962, USSR, Comdr. Walter M. Schirra, 6 orbits, 9 hrs. 13 min.

May 15, 1963, USSR, Maj. Gordon Cooper, 22 orbits, 34 hrs. 20 min.

June 14, 1963, USSR, Lieut. Col. Valery F. Bykovsky, 82 orbits, 119 hrs.

June 16, 1963, USSR, Valentina Tereshkova, 49 orbits, 71 hrs. ■

House Still Plans Big NASA Cut

LEADING Democrats of the House Space Committee said last week the latest Soviet manned flights in no way affect plans to cut NASA's Fiscal 1964 $5.7-billion budget severely.

The cut will probably be "around $500 million," Chairman George Miller (D-Calif.) again told Missiles and Rockets. The full Committee, which meets this week, is expected to approve subcommittee recommendations without restoring any cuts.

The Space Sciences Subcommittee, handling the request for the Office of Space Sciences and the Office of Advanced Research and Technology, has voted a $139-million slash—$89.2 million or 12.1% for OSS, $18.5 million or 5.6% for OART, and $32 million or 30% for construction of facilities in both programs.

- **Other programs**—*Ranger* was cut by $25 million, and the *Surveyor Orbiter* program was wiped out completely ($28.25 million). *Mariner* was reduced by $15 million.

Bioscience programs were reduced by $14 million, and a $4-million request for follow-on international satellite studies (this does not include any now being negotiated) was dropped. Launch vehicle development was cut by $3 million.

- **OART Programs**—The *Advanced Fire* project was eliminated at $8.5 million. Human engineering programs were cut by $5 million, and the Nuclear Rocket program by $5 million.

The Subcommittee on Applications, Data Acquisition and Tracking has voted to cut its portion by $90 to $95 million, Subcommittee Chairman Ken Hechler (D-W. Va.) told M/R.

- **Manned Space Flight**—The biggest cut will come in Manned Spaceflight area, which will be reduced by about $257 million. The $1.3 billion request for Project *Apollo* will be reduced by 10% and $60 million requested for the M-1 engine is being trimmed almost completely. Project *Gemini* funds of $306 million have been left intact.

Critics at AIAA meet say . . .

AF Can't Agree on Spacecraft Design

Observers from services and industry cite division between backers of 'true spacecraft' and conventional takeoff concepts

by Willard E. Wilks

LOS ANGELES—The Air Force is not much better prepared today to define the manned operational spacecraft that would best serve its needs than it was several years ago, if observations noted at the summer meeting of the American Institute of Aeronautics and Astronautics are to be believed.

This estimate of where matters stand is based on statements from both military and industry sources that the Air Force is not yet able to choose between two approaches to its first manned operational spacecraft—1) a vertically launched "true" spacecraft concept, and 2) the conventional takeoff and landing approach represented by *Aerospace Plane*.

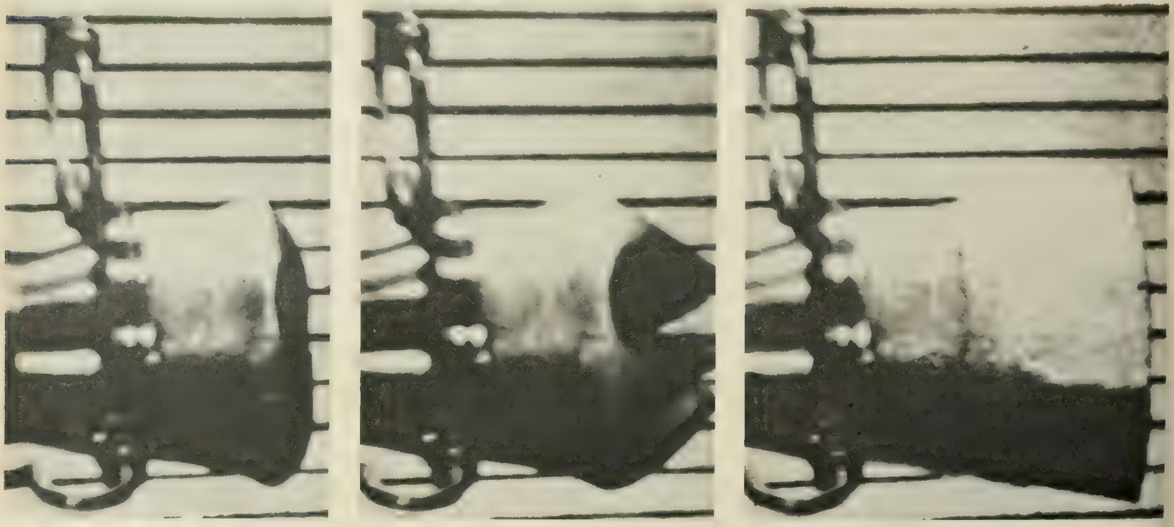
This uncertainty, not new but nevertheless revealing how firmly the military space program remains on the pad, cropped up after presentations on recoverable spacecraft that are being proposed to both Air Force and NASA. They include Douglas Aircraft Co.'s two-stage Astro concept, and Aerojet-General's 10-million-lb. gross-weight single-stage-to-orbit Astroplane.

One industry spokesman, admittedly with a proposal to sell, told MISSILES AND ROCKETS the Air Force is split into two factions—those who favor the first approach and those who prefer the second. Other spokesman, including Air Force, declare this is an overstatement. "If you go to Wright-Patterson, where Aeronautical Systems Division is working on *X-20* and *Aerospace Plane*, you're naturally going to find the air-breathing system favored," an Air Force source said.

"If you go to Space Systems Division, you'll find they want to get into space as soon as possible to counter whatever threat develops, and they don't want to take 10 years of development to do it." He added that "when the requirements are laid down from the top, the Air Force will make a decision and proceed."

According to those who believe the Air Force is in no position to select the proper approach, the requirements must stem in time from three sources—1) continuing experience in space technology, 2) leadership and decision-making at top levels in government, Defense Department and Air Force, and 3) Russian developments.

- **Time awasting**—Those who think a decision is possible now argue that time is not cheap and that a precious amount is slipping away while the situation is "studied." And, according to their view, the requirements for a beginning on military spacecraft development al-



AEROJET-GENERAL photos show successful test of one of its propose expandable nozzles for the Apollo Service Module. Ablatively cooled elastomeric material tucked into combustion chamber is expanded by gas following ignition.

ready have been laid down.

They point to such statements as that made by Dr. C. L. Kober, Director, Advanced Technology, Martin/Denver, at the AIAA meeting. Kober, who took no part in debating the issue, declared that "Russian bombardment satellite systems could appear at any time, and would, under present conditions, increase the probability of success for a pre-emptive strike against us."

This means, say those who favor going ahead with development of a vertical launch system without waiting for *Aerospace Plane,* that mission requirements are already clear: reconnaissance, inspection-interception, and maintenance and rescue.

"Some of the Air Force people who favor waiting for development of *Aerospace Plane* are using out-dated airplane-type thinking," MISSILES AND ROCKETS was told. "They are building another Maginot Line. Why do they want to tool around in the atmosphere before reaching orbit? You can reach orbit very quickly with a vertical launch."

Others point out that *Aerospace Plane* would have offset launch capability, being able to cruise out to meet the orbit plane required for a particular mission—an important point for rendezvous and inspection purposes. They add that *Aerospace Plane* also would have hypersonic mission capability if that becomes a requirement.

The Air Force does not now have a "firm requirement" for either of these capabilities, a spokesman noted.

A point generally agreed upon is that a vertical-launch spacecraft could be easily hardened by silo emplacement, while hardening a horizontal takeoff strip would be difficult.

Some engineer critics of the so-called airplane-type approach seriously believe that trying to combine two technologies in one vehicle—aviation and space—is a mistake that can only result in an expensive "bastard" approach.

Other experts are equally convinced that "we'll have to borrow from both to get an effective device." According to one, this idea is now beginning to receive more widespread acceptance than ever before.

It is conceivable that the route the Air Force takes could be decided by which Air Force division winds up in control of manned spacecraft. Rumor says that Space Systems Division could take over this responsibility. If this were to happen, there is little doubt in the minds of some observers which approach would be pushed hardest.

● **Astroplane**—Meanwhile, both Air Force and NASA have two new proposals to consider. Latest is *Astroplane,* which Aerojet has studied in three sizes. Dr. John C. Moise, limiting his discussion to *Astroplane-10,* signifying its gross takeoff weight, told M/R Aerojet has made informal proposals so far. If interest is high enough, Aerojet will make a formal proposal, "probably a joint one with a major airframe company."

Astroplane utilizes swept-wing propellant tankage to provide lift and stability required for glide recovery following vertical launch. It is 423 ft. across at its swept-wing tips, and stands 260 ft. high, carrying a crew of two or three in a capsule that would have abort capability throughout the entire flight configuration, including re-entry.

Astroplane, a hydrogen-oxygen rocket powered by 10 M-1 engines, each rated at 1.5 million lb. thrust, could place 440,000 lbs. into low orbit. To provide the most efficient load-carrying structure, the oxygen, about 74% of the total vehicle liftoff weight, is located in tapered, partial cylinders oriented normal to the longitudinal axis.

Liquid hydrogen, approximately 15% of the liftoff weight, is contained in the swept-wing tanks. Thrust vector control is provided at each tank tip by four gimbaled, throttleable engines, each of 100,000 lbs. thrust.

With a pricetag of $40 to $100 million for each vehicle, Aerojet estimates total operating costs of $10 per orbital payload pound.

● **And Astro**—*Astro*—an aerodynamic spacecraft two-stage reusable booster—will be formally proposed later this year, according to Douglas. Consisting of two vehicles, booster and spacecraft, both delta-wing-type lifting entry configurations, *Astro* could place a payload of 37,150 lbs. in a 300-nautical-mile circular orbit for a total cost of $41 per pound.

Douglas has already proposed the concept to the Air Force for use as a space trainer which could later be converted to meet rendezvous, interception, maintenance and rescue requirements. The two vehicles are nearly identical in configuration. The booster, with a one-man crew, is 95 ft. long with a 44 ft. wingspan. Douglas estimates $3.5 billion for 24 spacecraft and 12 boosters operating over a 10-year period.

● **Expanding nozzles**—Upper-stage nozzle skirts capable of being collapsed and packaged are being proposed informally for the *Apollo* Service Module by Aerojet-General Corp.

At ignition, gas pressures expand the skirts into their proper shape. By permitting the use of large, very-high-expansion-ratio nozzles without weight penalties, the concept enables designers to make wider use of simple, reliable pressure-fed engines with low chamber and tank pressures.

One version of the expandable nozzle cone is a pleated skirt of thin, radiation-cooled stainless steel. The other is an elastomeric material which is ablatively cooled. A very large expandable cone could be draped over the top of the preceding stage until separation. The lengthwise convolutions cause no flow problems at ignition because boundary layer appears to thicken in the deep parts and thin in the high places, making an effectively smooth expansion cone. At full deployment, the convolutions disappear and the skirt anneals in its correct shape. In a vacuum environment it would not collapse at shutdown.

The ablatively cooled elastomeric material is tucked into the combustion chamber before ignition. Aerojet envisions spare nozzles for lunar landers which would be folded up and carried in the spacecraft for use in the event of nozzle damage during the landing. The company has been developing and testing expandable nozzles for three years.

Other highlights of the AIAA meeting:

—Joseph A. Walker, *X-15* pilot and chief test pilot of NASA Flight Research Center, called for the formation of a NASA advisory panel of test pilots to assure that the professional knowledge acquired in one program is available to test pilots in succeeding programs. He observed that many of the lessons learned in 1958 on the *X-15* are now being laboriously relearned by test pilots in the *X-20 Dyna-Soar* program.

—Synergetic orbital plane changes in which a lift-generating spacecraft dips into the atmosphere, uses aerodynamic forces to accomplish a turn, then accelerates back into orbit are being studied by USAF. It is believed that this maneuver will require less propellant than a plane change made entirely with propulsive energy. Air Force *X-20* test pilot Maj. Henry Gordon said the maneuver may enable designers to accept a lower hypersonic lift-drag ratio for lifting entry bodies, since a plane change would permit the pilot to turn toward his landing site without entering the dense lower atmosphere where lift-drag ratio will determine how far the vehicle can glide.

—The U.S. should develop military satellite intercept-inspect systems as part of existing ballistic missile complexes, according to Dr. C. L. Kober of Martin-Denver. The use of existing capabilities and trained personnel on these bases could approximately halve the total system cost, Kober said. Study indicates that existing ballistic missile sites can provide launch trajectories giving adequate defensive coverage.

—The AIAA Astronautics Award was presented to Astronauts Walter M. Schirra, Jr., and L. Gordon Cooper for their outstanding contributions to spaceflight. ■

At McNamara's direction . . .

Receptive Climate for Military Space Growing

Flexible Air Force plan could cost between $800 million and $3 billion, would employ existing or funded hardware

by Frank G. McGuire

LAST WEEK's Soviet space spectacular has brought into sharp focus a receptive attitude toward Air Force space missions that has been developing within the Defense Department for the past year.

Deputy Director of Defense Research and Engineering John Rubel at one time claimed there was no mission for manned military spacecraft. Defense Secretary McNamara has now directed the Air Force to orient its thinking toward finding optimum ways to establish "a method of inspection in space, identification of other satellites in space, rendezvous in space and the capability to neutralize hostile satellites."

Toward this end, the Air Force is planning a flexible, quickly attainable and highly cost-effective system intended to provide protection from military threats in the near-Earth environment.

The flexibility of the new concept is illustrated by the fact that it can cost between $800 million and $3 billion, use either *Titan III* or *Saturn* boosters, have the shuttle vehicle double as a roving inspector-interceptor, use *X-20, Gemini* or even *Apollo* vehicles for logistics on an interchangeable basis, and be multi-function in nature by having NASA scientists along to conduct scientific research.

The envisioned space station, a refinement of the Manned Orbital Development Station (MODS), would be compatible with as many different types of logistic vehicles, satellites and other spacecraft as possible.

• **Space system plans**—The Air Force's plan for the near-Earth environment will employ mostly existing equipment, but with the space station yet to be designed. The station, referred to by some Pentagon officials as a "canister," would act as a base to dispatch inspector spacecraft to investigate unknown satellites or other spacecraft. These inspector vehicles would also be the station's logistical and crew-transfer vehicle and could have the *X-20, Gemini* or *Apollo* configuration.

In the *X-20* and *Gemini* programs, proposals are being made by the contractors to modify the vehicles for use as shuttle craft between Earth and the space station.

Such elements of the system as new sensors, operational methods, weapons, propulsion schemes, electromagnetic warfare techniques, applications of nuclear power, and basic research on new military problems would be sought continually as a means of simultaneously carrying out R&D and evolving doctrine.

• **Later refinements**—After the initial phase of the system, better components, vehicles and methods would be produced. An aerospace plane, for example, should eventually replace the boosters and logistical vehicles for Earth-to-station transportation.

A minimal initial system, involving a single space station with several shuttles and appropriate boosters, could be in operation within four years at an estimated cost of $800 million. A system capable of far more complex operations would cost about $3 billion and begin operation in approximately the same time period. The $3 billion cost would be extended over five years.

The boosters involved in the program could be either *Titan III* or *Saturn*, and probably would be both, depending on the payload and mission. The Air Force is known to like the precision with which *Titan III* can be fired in a time-critical situation, but is actively trying to fit *Saturn* and its capabilities into the overall concept for greater flexibility and weight-lifting capacity.

• **Present climate explained**—Spokesmen close to the decision-makers in the Pentagon say the increased acceptance of Air Force arguments is due partly to logic, partly to Soviet achievements and partly to "the handwriting on the wall." There appears to be no argument that a serious threat exists in the form of U.S. and Soviet missiles and bombers poised to strike, but there is still some question within the administration about the nature of a space-borne threat, if any.

"Many people think the antithesis of peace is the military. This is not so," a Pentagon military-space advocate told MISSILES AND ROCKETS. "The antithesis of peace is war; and no military man charged with keeping the peace wants to get into a war any more than the cop on the beat wants to get into the middle of a riot. But he's there in case the situation gets to the riot point."

• **Disarmament compatibility**—The Air Force's plans contain one significant point insofar as missions are concerned: they parellel those plans put forth by the U.S. for the past several years as the basis for all disarmament—inspection, identification, and neutralizing when necessary.

All the necessary missions to carry out this overall aim can be accomplished from the orbiting space stations supplemented by inspector spacecraft, which would have the ability to neutralize a hostile vehicle.

Air Force thinking generally agrees with the desire not to cause any acceleration of the arms race by making belligerent moves in space. The idea, according to studies on the subject, is to have the capability in existence but without any belligerence attached to it.

• **Criticisms**—As recently as April, however, one of the Air Force's leaders described that service's military space program as "foundering badly" and lacking firm goals. The rationale for a military man in space was accused of being based on doctrinal or other inadequate arguments.

The current sharply-focused program laid out by the Air Force seeks to counter those criticisms and provide the military with as sound an argument as possible for its claims.

The Air Force, though not yet sure it has answered the administration's demands for clear-cut missions before issuing a green light, has come up with more clearly crystallized ideas of what it expects to accomplish.

In general terms, and omitting classified projects, these amount to support of ground activities (communications, weather and navigation), reconnaissance and surveillance, inspection and interception, defense of U.S. space activities, defense against ballistic missiles, and offensive weapon delivery. The last of these is given least credibility as an effective mission for spacecraft.

The current tendency in Washington is to go along with this new concept of relatively low-cost space systems that have flexible applications, use existing hardware and facilities for space operations, and have a strong ring of logic in their reasons for existence. ■

Under 'serious consideration' . . .

NASA's Lunar Logistics System Likely to Be Postponed

Two-year delay in hardware funding seen as supply vehicle takes on broader mission than merely Apollo support; more studies probable

by Hal Taylor

NASA IS EXPECTED to indefinitely postpone its Lunar Logistic System program, deferring any hardware funding for two years.

Space agency officials told MISSILES AND ROCKETS that "while no final decision has been made, postponement of the project is under serious consideration."

The thinking now, one official said, it that LLS should be used to construct a lunar base, not simply to support Project *Apollo*. Another spokesman added that this probably will mean a two-year delay in program approval.

The expected decision would mean that there would be no emergency equipment on the Moon to aid U.S. astronauts on the first manned lunar-landing missions. It also would mean that Administrator James E. Webb has overruled officials of the Office of Manned Space.

That group recently recommended approval of a LEM truck vehicle which could place enough supplies on the Moon to increase the stay time of U.S. astronauts by two weeks.

The vehicle—based on the Lunar Excursion Module descent stage—has an estimated development cost of $400 million. It was preferred over a 90,000-lb. logistic system which would cost over $905 million. In addition, both vehicle programs had an estimated $125-million cost per launch.

The Manned Space Flight Office recommendation followed three-month study contracts by three missile/space firms. Grumman Aircraft Engineering Corp. and the Northrop Aircraft Co. studied payload requirement for the logistics system, and Space Technology Laboratories, Inc. weighed possible spacecraft configurations.

In recommending the LEM truck, officials admitted that, while it would permit the space agency to phase into a lunar base, its 7,000-lb. payload would be inadequate to construct the base.

A decision to delay the program, however, will result in a complete new look at the program, one official said. More study contracts will be awarded to industry, he added, even if program approval is received this year.

While refusing to discuss the chances for program approval, Dr. William F. Lee, director of Advanced Studies in the Office of Manned Space Flight, gave M/R a detailed description of the two logistics systems under consideration.

- **Truck approach**—Dr. Lee said that the LEM truck configuration was selected because it requires no new propulsion stages, makes maximum use of already developed *Apollo* hardware's and utilizes the *Apollo* spacecraft for flight missions.

The LEM Truck $400-million price-tag includes $100 million for the spacecraft, $200 million for playload and $100 million for miscellaneous facilities around the nation, Lee added.

"Its capability can be roughly described," Lee said, "as providing a two-week stay time on the surface plus sufficient mobility to explore an area with a 50-mile radius."

It would utilize only the descent stage of the current two-man Lunar Excursion Module configuration. The capsule and ascent stage would be removed. Such equipment as attitude control, guidance and navigation, landing radar, tracking beacon and the inertial platform would be transferred from the capsule into the descent stage to make it a complete landing system. Other LEM equipment such as the life support system, wideband telemetry and television cameras would not be needed for the unmanned supply mission.

The LEM truck would not be enclosed, but would simply have a superstructure to which its payload could be attached. It would also have a docking ring for hooking up with the third stage of the *Advanced Saturn*.

The LEM truck payload would include a surface vehicle, a laboratory shelter, and scientific equipment.

The laboratory would be relatively simple, with a life support capability of only a few days. Two surface vehicles are being considered.

One design calls for a 1,500-lb vehicle which would have no cab or other protection to shield the astronauts from solar flares. This would limit the exploration radius to an area of 10 miles. A larger vehicle, which would take up all of the payload capability of 7,000 lbs., would be a modular two-man vehicle with sufficient shielding.

The scientific equipment would include such things as a seismometer, thermal and electric probes and a parabolic antenna.

For flight missions, the LEM truck would be attached to *Apollo* Command and Service Modules manned by its three-man crew. When the spacecraft reached lunar orbit, it would be detached for the automatic descent to the lunar surface. *Apollo* crewmen would control it only to the extent of avoiding surface obstacles.

- **Lunar base**—Lee said the heavy, 90,000-lb. logistics vehicle would have enough capability to set up a manned base on the Moon.

Two propulsion stages would take up two thirds of the weight, thus cutting its total payload to 30,000 lbs.

Its payload would include a complete Lunar Excursion Module for use in emergencies, a micrometeoroid shielding, and another 13,000 lbs. which could include a surface vehicle.

Its drawbacks as far as NASA is concerned include both its high cost and its requirement for two new propulsion stages—one for breaking into the lunar orbit and another for descent to the surface. ■

HONEYWELL ADVANCED TECHNOLOGY REPORT NO. 4

What is the key to successful

Program Management techniques cut costs on Polaris platforms

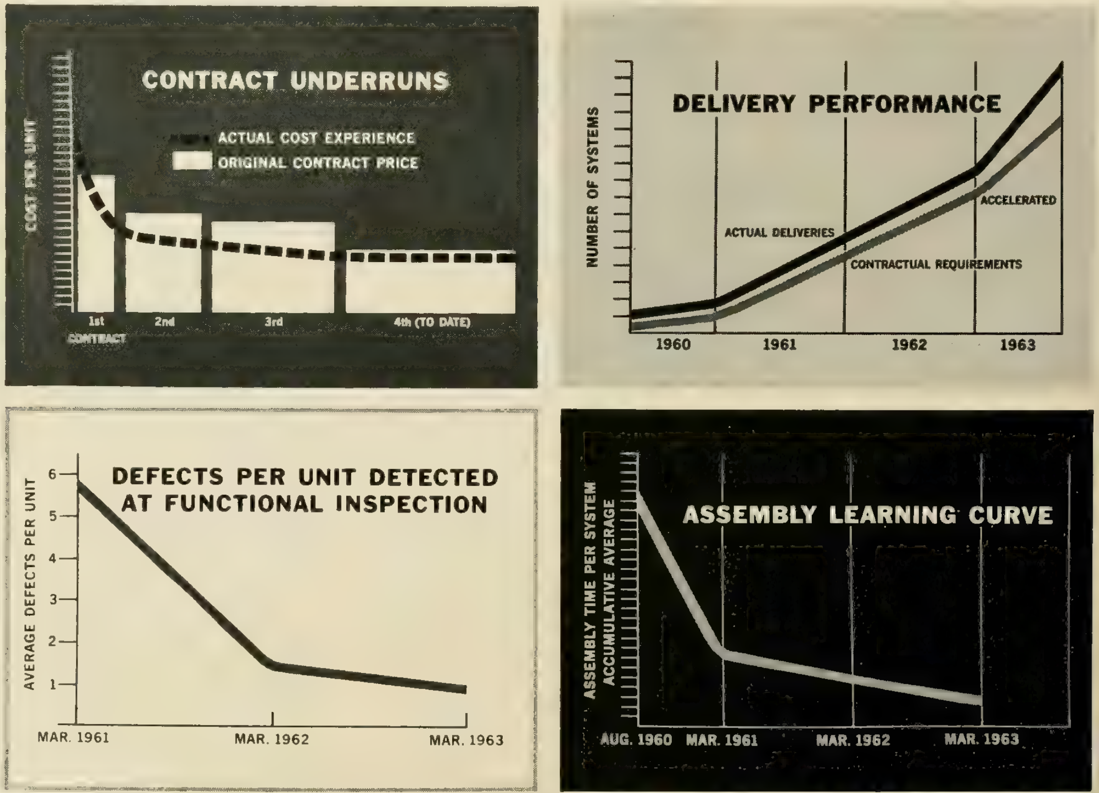
As a result of successful Program Management, the first Mark I inertial platform built by Honeywell for the Polaris guidance system retained the green light throughout the countdown. Utilizing an MIT design on a second source program, Honeywell delivered the unit 30 days ahead of schedule—117 days after the order was received. Every subsequent delivery date has been met.

Besides meeting schedules—some of which were sharply accelerated—Honeywell has reduced the unit price on each successive contract while meeting all quality specifications.

The Program Management techniques that made the Mark I program successful are now being applied to the Mark II system which Honeywell is building for the advanced Polaris A3.

Much of the success of Honeywell's Polaris programs has been credited to its Program Manager organization. This management technique makes the Program Manager fully responsible for the entire program—cost, delivery, performance and reliability. In addition, he is also accountable for production engineering, production control, system engineering, assembly, technical liaison, cost control and, indirectly, quality.

The individuals responsible for these functions devote full time to Polaris, and are located in the same offices to shorten lines of communication and provide quick reaction to any problem areas.



Results of successful Program Management at Honeywell in building the Mark I inertial platforms for the Polaris missile are shown above. Every unit was delivered on or ahead of schedule with cost underruns on each successive contract.

Program Management?

Incentive-type government contracts demand further refinement of management techniques

New procedures in government contracting indicate that in the future more and more emphasis will be placed on the *management* aspects of complex defense and space programs.

At Honeywell, increased emphasis is being put on refining Program Management techniques because: (1) The concepts of Program Management match trends in both government and industry toward centralizing authority and responsibility; and (2) Program Management shows *exactly who* is accountable and who can present the total picture of a program's progress to both top management and the customer.

To make Program Management more effective and efficient, a Program Manager should:

1. Establish cost and technical goals. These must be set—and met—by the Program Manager within limits prescribed by the customer. The Program Manager must have both technical and administrative abilities to direct all tasks on a results-oriented basis.

2. Direct subcontractors. Since up to 75% of all prime contract dollars go to subcontractors, the Program Manager must assist in selecting subcontractors and he must direct this portion of the program. The Program Manager should hold Task Team meetings to discuss all important aspects of the program and present design material in detail. This will expose potential problem areas for action.

3. Maintain design and financial controls. The Program Manager should be supported by financial tools (such as weekly program cost records) which quickly evaluate expenditures and alert him to potential cost problems and technical delays. Value Engineering should be used to seek out less costly alternatives in equipment design and production.

To help the Program Manager carry out these responsibilities, top management must:

1. Delegate authority and responsibility. The Program Manager must in effect run a company-within-a-company.

2. Provide manpower. Technical and financial specialists of the entire company must be available to the Program Manager.

Important as these basics are, they can be made to work only by an *able and experienced* Program Manager. It is at this crucial point that the Program Management concept most often fails.

The *long range development of the individual* is the key to having personnel available and experienced in Program Management. At Honeywell, the potential Program Manager is singled out early in his career and exposed to varied on-the-job training with heavy emphasis on supervisory experience. If he scores consistently high, he is recognized as a potentially successful Program Manager.

At the left and below are examples of the techniques that have helped Honeywell achieve its respected record of Program Management.

Quick build-up results in major production plant in 5 months

A recent step-up in Army Ordnance requirements resulted in the build-up of a 400,000 sq. ft. automated production facility by Honeywell in five months—less than half the time normally required. In 45 days after go-ahead, Honeywell had the first high-volume production lines in operation, and delivery schedules were met within four months. A 5% underrun was achieved during the first eight months and the costs of all successive systems were reduced significantly.

This quick build-up was made possible by:

1. Program Management. A key individual—the Program Manager—was given full authority and held accountable for all phases of the build-up of the new facility.

2. Concurrency. Detailed planning allowed the Program Manager to develop separate elements simultaneously, so that completed elements dovetailed into workable units.

3. Training program. 2,000 new hires were fully trained and ready to begin work as production lines were completed.

4. Communication. The Program Manager kept both the customer and management informed throughout the accelerated build-up.

5. Importance of the individual. Technicians and production personnel were given a sense of urgency and personal importance through their contribution to the program.

ENGINEERS AND SCIENTISTS: Explore new professional opportunities. Write Mr. Fred T. Laing, Honeywell, Minneapolis 8, Minnesota.

Honeywell

Circle No. 10 on Subscriber Service Card

STANDARD SUCCESSFULLY PRODUCES 156-IN. MISSILE BOOSTER RINGS

The nation's 18% Nickel technology is rapidly advancing at Standard Steel, where the first 156-in.-diam. booster rings are being rolled for use in a new missile program.

Maraging steel was selected because of its remarkable combination of strength, toughness, ease of heat treatment and welding, and freedom from distortion. The toughness of 18% Nickel depends on precise control of finishing temperatures—a technique which Standard has successfully developed.

Standard's capabilities in vacuum arc remelt steels and long experience in ring rolling are unique in industry today. Other recent 18% Nickel applications to which Standard has contributed include conditioned ingots and blooms for a missile dome test project, forged components for an industrial pump and preforms for a rocket motor case evaluation program

Now that Standard has helped prove that 18% Nickel can b worked with present equipment and techniques, you shoul investigate its use in a wide variety of defense and industria applications. Write for additional information.

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Circle No. 11 on Subscriber Service Card

Technical Countdown

ELECTRONICS

Optical Signals Transmitted by Mirror

Voice communications at optical frequencies are being accomplished using a mirror-surface corner reflector for modulation and transmission, according to scientists at ITT Research Institute (formerly Armour Research). At the receiving end, a photoelectric cell is used to convert the light energy into electric impulses. These are then amplified and fed into a conventional speaker for audio reproduction. Called a Retrometer, the system is being developed by the Institute under NASA sponsorship for space use. One of the reflector surfaces is a 0.0005-in. film of aluminized Mylar and thus serves as a vibrating mirror to modulate signals.

Telstar II In Fine Shape, Says BTL

Lightly shielded test transistors employed in *Telstar II* are experiencing a radiation-damage rate only one-fourth that of similar devices in *Telstar I*. The reason, according to Bell Telephone Laboratories scientists, is *Telstar II's* reduced exposure time because of its higher apogee and the partial decay of higher-energy electrons remaining from the Johnston Island high-altitude nuclear test last year. Over 270 technical tests for broadband communications (TV, telephone, data, and facsimile) have been conducted by BTL during the first 200 orbits. Tracking accuracies have been improved to within 0.02 degree for the precision tracker and 0.005 degree for the horn-reflector autotrack system.

Fewer Denizens in Nuclear Jungle?

Only two basic particles populate the so-called nuclear jungle instead of the 30 or more thought discovered in the last decade. These are the baryon and the lepton, and any others are merely different states of the basic particles. This is the highly controversial theory recently enunciated by Dr. Victor F. Weisskopf, Director-General of the European nuclear research center CERN in Geneva. He contends, for example, that protons and neutrons are different forms of the baryon while the electron, muon and two types of neutrinos stem from the lepton.

Gemini Rendezvous Radar Nearly Ready

Westinghouse Electric Corp.'s Air Arm Div. will deliver the first production version of the *Gemini* cooperative rendezvous radar system to NASA this summer. Several engineering models already have been delivered. WEC engineers are highly optimistic about reaching the 1,000-hr. MTBF level for the production unit, based on failure-free performance of several hundred hours using relatively unscreened, randomly chosen components in earlier test models.

Near Speed-of-Light Camera Revealed

A "Miracle" camera able to "photograph processes occurring at speeds comparable only with the speed of light" has been developed by the Leningrad Institute of Motion Picture Engineers, a recent *Pravda* story reveals. Operating at up to 500 million frames a second, the camera operation is said to be based on use of an array of small optical scanners consisting of several thousand miniature lenses which break down the image of the object into extremely small elements each with a diameter of hundredths of a millimeter. Scanning speed is given at 15,000 m/sec. *Pravda* says that with the help of rotating mirrors, the image is transmitted to a fixed photoplate. If the Russian claim is true, the camera could be superior to any in the U.S. today experts say.

13-Month Apollo Negotiations Near End

Formal NASA contracts for two of the three *Apollo* command module guidance system developers were signed last week. This follows their selection by the space agency as principal participating contractors by just over one year. Reported contract values were as follows: AC Spark Plug Div. of General Motors—$35.8 million (navigation and guidance system); Raytheon Co.—$15 million (guidance computer). Kollsman Instrument Corp., which will develop the optical subsystems, is still negotiating its contract.

ADVANCED MATERIALS

Pure Tungsten Powder Produced

Tungsten powder having a 99.999% purity is being produced by Materials Research Corp., company officials claim. Prepared from equally pure single crystal tungsten rods, the material is available only in sample quantities of various particle sizes ($40.00/10 grams). First application for the urgently needed material probably will be in making high-porosity sintered tungsten ionizers for ion-propulsion space engines.

Full Weld Penetration Achieved with René 41

A method for fusion-welding René 41 that assures 100% weld penetration has been developed by General Dynamics/Pomona. The technique also eliminates the danger of cracking by providing very rapid heat dissipation during the welding operation. A designed, heavy-wall tubular butt-joint is manually fusion welded in the GD/P approach. Weld members are rigidly held in proper alignment during welding by means of a thin-wall, internally press-fitted René 41 back-up ring. The ring also supports the molten puddle of the weld.

Rugged SS Metal-to-Glass Seals Available

Glass- or ceramic-to-stainless steel seals can effectively withstand temperatures varying from —435° to 1,000°F, according to Networks Electronic Corp. The Chatworth, Calif., firm claims also that such seals have met all the environmental requirements of MIL-C-26500.

PROPULSION

Sprint Propellant Contract Awarded

Lockheed Propulsion Co. is already at work developing the high-performance propellant for the *Sprint* anti-missile system. The company announced last week receipt of a $1.3-million contract from the Army's *Nike-Zeus* project office. R&D on the highly classified program will be performed at Lockheed's Redlands, Calif., facility.

Standard Engine Ordered for Bullpup Trainer

A "large quantity" of Thiokol Chemical Corp. LR58 packaged liquid engines has been ordered by Air Force for use in GAM-83 training missiles. Part of a much larger Navy Production contract for the *Bullpup A* rocket motors, Thiokol claims the additional order resulted from sharply reduced per-unit costs and anticipates further price cuts.

Huge Nozzles Economically Feasible

Fiberite Corp. eliminates massive processing equipment through new tape-winding method

by John F. Judge

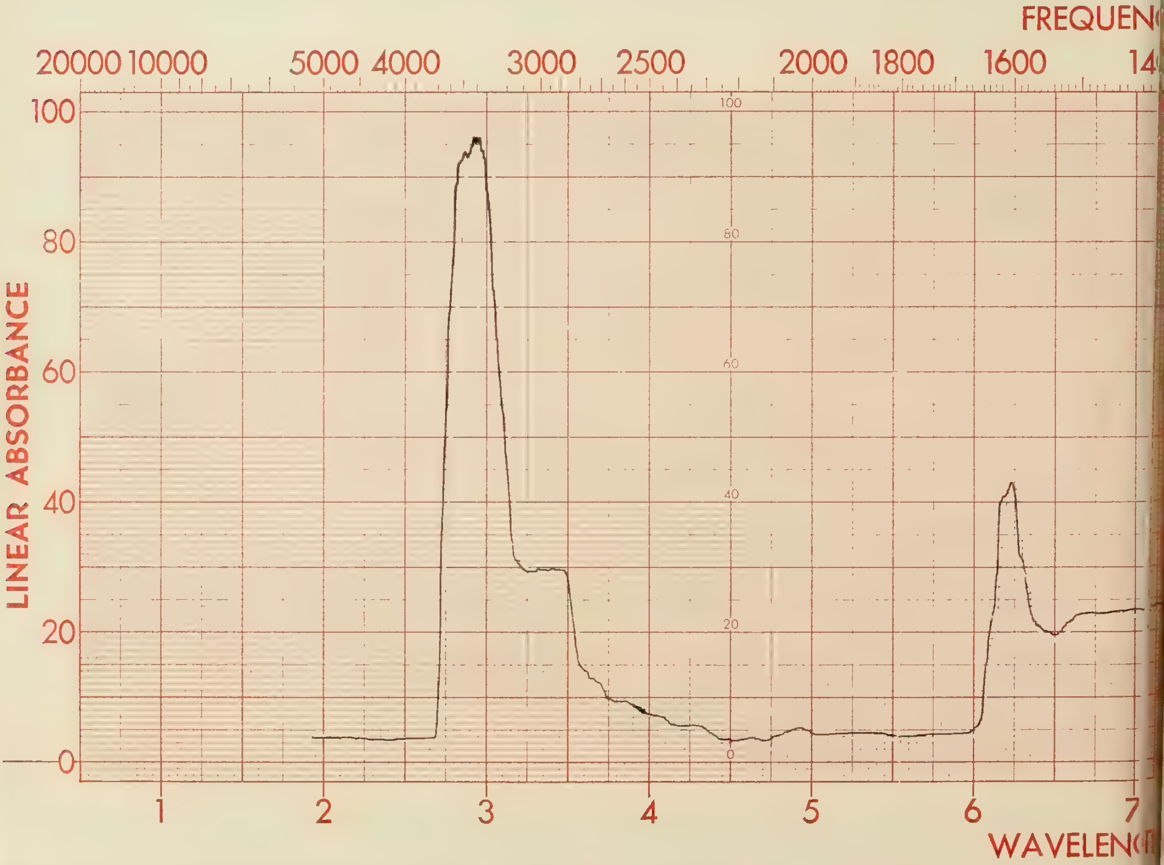
ROCKET NOZZLES of virtually unlimited size may be economically tape-wound without compromising necessary mechanical or thermal properties through a new process under development at Fiberite Corp., a division of Universal Manufacturing Corp.

The process—which involves progressive curing during winding—eliminates the need for huge pieces of equipment such as autoclaves, hydroclaves and presses.

The key to the novel fabrication method lies in the development of a new, fast-curing resin system adaptable to all established ablative reinforcing materials.

A long-time materials supplier to the missile industry, Fiberite also perfected an inexpensive infrared, routine test procedure aimed at definite control of materials properties—and thus fabrication characteristics.

Don Schemanski, director of re-



SAMPLE TRACE of resin advancement as measured by Fiberite. Peaks represent open reactive sites on benzene molecule.

search, says Fiberite is not interested in producing structures but only in assuming responsibility for establishing the necessary fabrication criteria to support design properties.

The large booster programs being initiated pose new and unique problems for supporting contractors, says Schemanski, in that the first firings must be successful. It is not economically feasible to expect numerous test firings strictly for component development.

Thus the materials supplier must now provide design data, control specifications, fabrication criteria and coordination, plus a definite control of fabrication characteristics, says Schemanski.

In line with this, Fiberite expanded laboratory facilities to include tape-wrapping research in an effort to provide customers with materials and vital data.

The main result is the SNAP-51 resin system and creation of an infrared spectrophotometric polymerization index. A side benefit was the design of wrapping devices incorporating the progressive cure concept. Several major fabricators have indicated interest in these designs.

- **Adapted resin**—The SNAP-51 resin system consists of a state-of-the-art MIL-R-9299 resin and curing mechanism. The resin can be adapted to impregnate all commercially available reinforcing refractory fibers in paper, felt and fabric forms.

Resin properties have been tailored and controlled within limits applicable to the winding-cure approach. These properties include:

—Resin rehology—The flow characteristics of the uncured resin influenced by heat, pressure, volatile content, the degree and rate of polymerization have been adjusted to the progressive curing method.

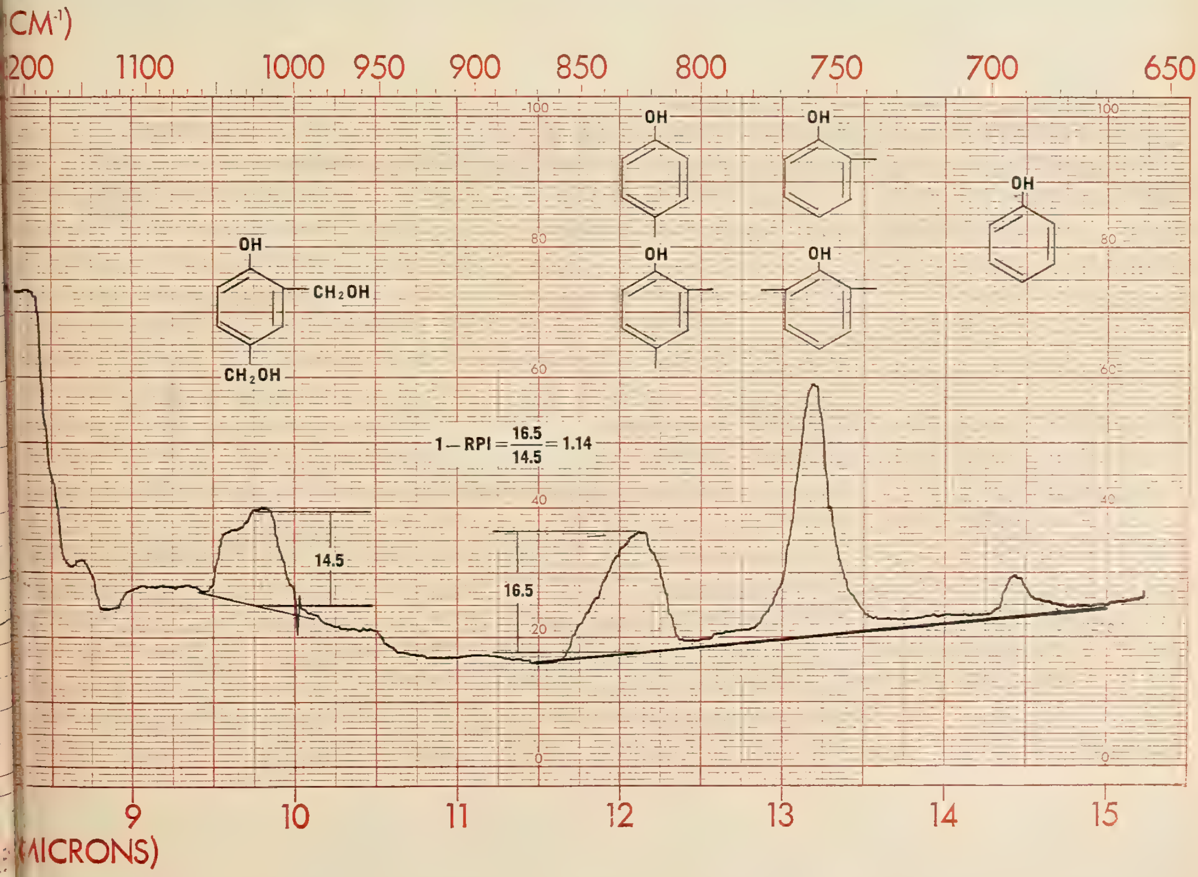
—Gel time—This refers to the time associated with the polymerization of the resin to a non-tack, dry rubber state. This time can be varied between 30 and 240 seconds, depending upon requirements. The resin is not completely cross-linked or cured, though it is thermoset and will not melt.

—Cure time—This period is the time required to completely thermoset, polymerize or cross-link the resin with available chemical linkages. It can be varied between 60 and 360 seconds.

—Heat-distortion point—The gelled resin must have a heat-distortion point above the wrapping temperature to provide the necessary column strength. This insures that the bulk factor and subsequent density of the wrapped preform is the optimum.

- **Processing technique**—The primary method is one of progressively curing a tape of SNAP-51-impregnated fabric by the continuous application of heat and pressure. Both are applied as the tape is wound onto the mandrel or mold form.

A typical procedure would consist of preheating a controlled tensioned



tape by infrared heat lamps immediately before wrapping. Preheating will cause the tape to develop upon application to the mandrel where it is subjected to constant pressure to obtain maximum density. Pressures used have been in the 50- to 500-psi range with a curing temperature of 300°F.

The rapid cure of the molding tape maintains the resin and fiber distribution as impregnated. De-bulking and consolidation is effected as each layer is applied, eliminating additional fiber movement.

Conventional processes use slow curing systems with a long fluid phase where resin flow occurs. This could result in severe segregation and non-uniform characteristics significantly affecting the thermal and mechanical properties, says Schemanski.

The snap cure process can be observed and processing parameters adjusted during winding. This process can be stopped and restarted simply by rapidly cooling and reheating the depth of the active cure phase.

Hydroclave, autoclave and vacuum-bag approaches do not permit observation during the cure cycle. These methods also must be adjusted to the average characteristics of the numerous batches of materials committed to one large structure.

• **Clean process**—The snap-cure method inherently provides a short escape path for resin condensation products and entrapped air. The surface cure ability generates volatiles to a very shallow depth. Some resin movement occurs toward the outer edge of the tape and away from the mandrel services. This movement will essentially remove all by-products and volatiles within a given layer.

A controllable, uniform heat input per-unit weight of material is applied as the tape is wound. Schemanski says conventional processes require heating a large mass of material by conduction through the material itself, which has a very low thermal conductivity. Severe temperature gradients result.

Distortion problems due to shrinkage and non-homogeneous structures is eliminated through uniform temperature characteristics coupled with the removal of volatiles during the curing of a minimum number of plies.

The SNAP-51 resin has been adjusted for rapid polymerization at the temperatures and pressures used in this process. The curing time must be greater than that required for one mandrel revolution and less than the time needed for 20 revolutions.

The minimum time is established to insure mechanical and chemical bonding between successive layers, Schemanski says. The maximum time limits the depth of uncured material. This depth is necessary to insure that the applied pressure is effective through the time required for complete cure—or until the polymerization has proceeded far enough to raise the heat-distortion point above the processing temperature.

• **Materials tested**—Fiberite researchers evaluated the physical and thermal properties of a number of materials such as high silica, carbon and graphite cloths impregnated with the SNAP-51 resin.

A typical example involved MXS-51, a high-silica fabric treated with the snap resin. Plies were cut and fabricated by progressively curing each ply 40 seconds before application of the subsequent ply.

In this experiment, one ply was placed in the mold at 300°F. and 200 psi applied for 40 seconds. The mold was opened, a second ply introduced and again cured in an identical manner. The procedure was continued until a laminate of sufficient thickness (⅛ in.) was achieved.

The control sample was obtained by using a standard molding procedure in which all the plies were introduced at the same time. A cure cycle of 20 minutes at 500 psi followed.

The following properties were identical in both samples:

Resin solids	31%
Specific Gravity	1.70
Compressive strength	40,000 psi
Rockwell Hardness	60
Thermal Conductivity at 300°F.	2.4
Coefficient of linear Thermal Expansion:	
Normal	45 x 10^{-6}
Parallel	48 x 10^{-6}

The following properties differed:

Property	**Standard**	**Progressive**
Flexural Strength, psi	17,000	22,400
Modulus & Flexure, psi x 10^6	2.0	3.1
Tensile Strength, psi	10,000	12,700
Shear Strength, psi	5,500	6,500

• **Definitive fabrication tests**—The Fiberite Infrared Polymerization Index has all the desired qualities of a routine control test. The equipment is reliable and widely available, while the test method itself is rapid and economical enough to be used on a production schedule.

Fiberite experts used gas chromatography and proton magnetic resonance approaches to verify and confirm the infrared analysis. The infrared procedure essentially indicates the disappearance of reactive sites on the resin benzene ring.

Since previous experiments disclosed that a resin advances in molecular weight (i.e. "cures") through cross-linking at reactive sites on the benzene nucleus, keeping tabs on the sites actually measures the advancement state of the resin.

These reactive sites consist of methylol groups (CH_2OH) and are identifiable on the infrared-absorption spectrum at 9.8 microns (see trace). As the resin is advanced, the reactive sites are converted into methylene and either linkages connecting the benzene nucleus in a three-dimensional network, which, if carried to the C stage, approaches an infinite molecular weight.

There are four more significant absorption bands in addition to the methylol one, says Schemanski. The band at 8.0 microns results from hydroxyl deformation and is used only in standardization.

The band at 12.2 microns is due to 4 and 2, 4 disubstituted phenol, the 13.2 band to 2 and 2, 6 disubstituted phenol and phenol, and the 14.4 band to phenol.

In measuring the relative advancement of the various resins, a procedure is required to compensate for concentration dependence and lack of strict compliance with the Beer-Lambert Law. This postulate states that while each layer of equal thickness absorbs an equal fraction of the light traversing it, the absorption of different concentrations of solutions is a direct function of concentrations.

• **Acetone good solvent**—Acetone is the most acceptable solvent, says Schemanski, because of its dissolving power and its lack of absorption peaks in the measurement area. In the procedure as developed at Fiberite, a resin sample is extracted from treated material and injected into a matched cell. Cells are placed in a double-beam infrared instrument for scanning.

The hydroxyl-deformation band is used for the final adjustment of concentration. The concentration of the extract should be adjusted to produce an absorbance between 0.70 and 0.75 at 8.0 microns, says Schemanski. Then the sample need only be scanned from 8.0 microns to 15.0 microns.

The chart produced is then prepared for analysis by drawing base lines. The methylol base line is drawn tangent to the curve at 9.45 microns, to, and tangent to, the curve at 10.15 microns.

The 12.2 base line is constructed tangent to the curve at 11.5 microns, to and tangent to, the curve at 15.0 microns. The 12.2 band is used as an internal standard because of its stabilit and low free-phenol sensitivity.

The absorbance is calculated between the curve and the base lines a 9.8 microns and 12.2 microns. The index is determined from the ratio o 12.2 absorbance to 9.8 absorbance. Thi 12.2/9.8 ratio produces an index number that increases with the increase o advancement of the resin.

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gner ended with the bare vehicle—the airplane, tank,
, submarine, etc. When a "standard" model had been
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ptional equipment is added to a car.

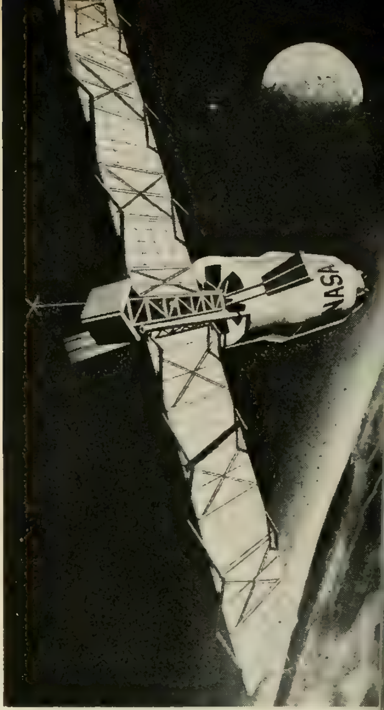
as the United States progressed first into the missile
and then into the space age, urgent requirements
for huge, intricate, frequently unmanned machines
ble of carrying out fully automatic missions in strange
environments. The job of designing, engineering,
ucing, and testing a single weapon or space system
became one of integrating all of the system's innu-
ble elements at the same time and ensuring that
all work harmoniously toward the same final goal.

systems approach to engineering has worked pro-
l changes in industry and management. Whole jobs
rely given to single contractors. More often they are
buted among hundreds and even thousands of companies who are stacked in giant, multi-layered pyramids crowned by one or more prime contractors and an assortment of government, military, and industrial managers.

Systems management actually occurs at all layers of the pyramid structure, reaching its greatest level of sophistication at the peak.

An aerospace systems manager is an entirely new kind of executive in the world's biggest business. His knowledge must bridge many arts and sciences. He must master detail without ever losing sight of the big picture. He amalgamates many elements of varying complexity, function, and geographic origin into a single massive entity that must perform with split-second precision. He controls the constantly shifting interaction and trade-offs between time, cost, and performance.

The new science of systems management and engineering is a testament to man's intellectual growth and an indispensable tool for speeding the instruments of our survival and mastery of space. **NORTHROP**



Meteoroid Detection Satellite Mock-up Shown

Fairchild system slated for launching aboard Saturn in mid-1964; deployment successful in demonstration

by Charles D. LaFond

THE FIRST FULL-SCALE mockup of the *Meteoroid Detection Satellite* has been demonstrated for NASA officials by Fairchild Stratos Corp. at its new Space Systems Division near Washington, D.C.

Fairchild, prime contractor under a $6.5-million dollar contract awarded last March by Marshall Space Flight Center, will build one test prototype and three flight-quality MDS spacecraft. The first of the giant space research vehicles, weighing roughly 3,400 lbs. and having a "wingspan" of more than 100 ft. when deployed, is scheduled to be launched atop a *Saturn* booster at Cape Canaveral in mid-1964.

At the recent demonstration for NASA Headquarters and Marshall SFC personnel, the highlight was the successful operation of the prototype deployment mechanism used to extend each of the 50 ft. x 15 ft. meteoroid-detection assemblies.

Ultimately, two MDS systems will be placed in Earth orbits varying from 300 to 800 miles in altitude. Each will electronically measure and relay to ground stations the frequency of space particles penetrating the panels, and will compare performance of protected vs. unprotected solar cells in the space environment.

The spacecraft and all its subsystems will be provided with parallel or redundant circuits and mechanisms to help assure a one-year operating life in orbit.

A determination of meteoroid activity and their characteristics is necessary to support the manned space program. Many observers believe that if the early MDS program meets expectations, it may well signal the beginning of similar probes into the lunar and interplanetary regions of outer space.

- **Mission**—Two parameters are needed to evaluate the hazard of meteoroid impact with state-of-the-art spacecraft: (1) the frequency of meteoroids per unit of time and area having sufficient mass and energy to significantly damage spacecraft structures or equipment; (2) the directional characteristics of meteoroids as a function of penetrating power and frequency.

Mass and energy spectrum data in the intermediate range are needed most, according to Fairchild scientists. Data concerning relatively large and relatively small meteoroids are currently available.

If the directional properties of meteoroids can be developed, scientists report, then the probability of meteoroid damage can be reduced by proper spacecraft orientation.

- **MDS design**—An overriding factor in the MDS design requirements is the need for full development of the system within one year. Subsystems must be held to use of space-proven hardware, developers point out.

The satellite configuration is based on the use of an open-truss, rectangular center structure from which two accordion-folded detection assemblies or wings will be extended following orbital injection. The center structure measures 16 x 7 x 2 ft., the wings approx. 50 ft. x 15 ft. x 2 in. Before deployment, the whole will be contained within a 110-in.-dia. cylindrical outer shell. Total deployment time will be one minute, designers say.

A redundant d-c auxiliary motor drive contained in the center structure is used to limit the wing extension rate. Explosive bolts release the extension mechanism for wing deployment.

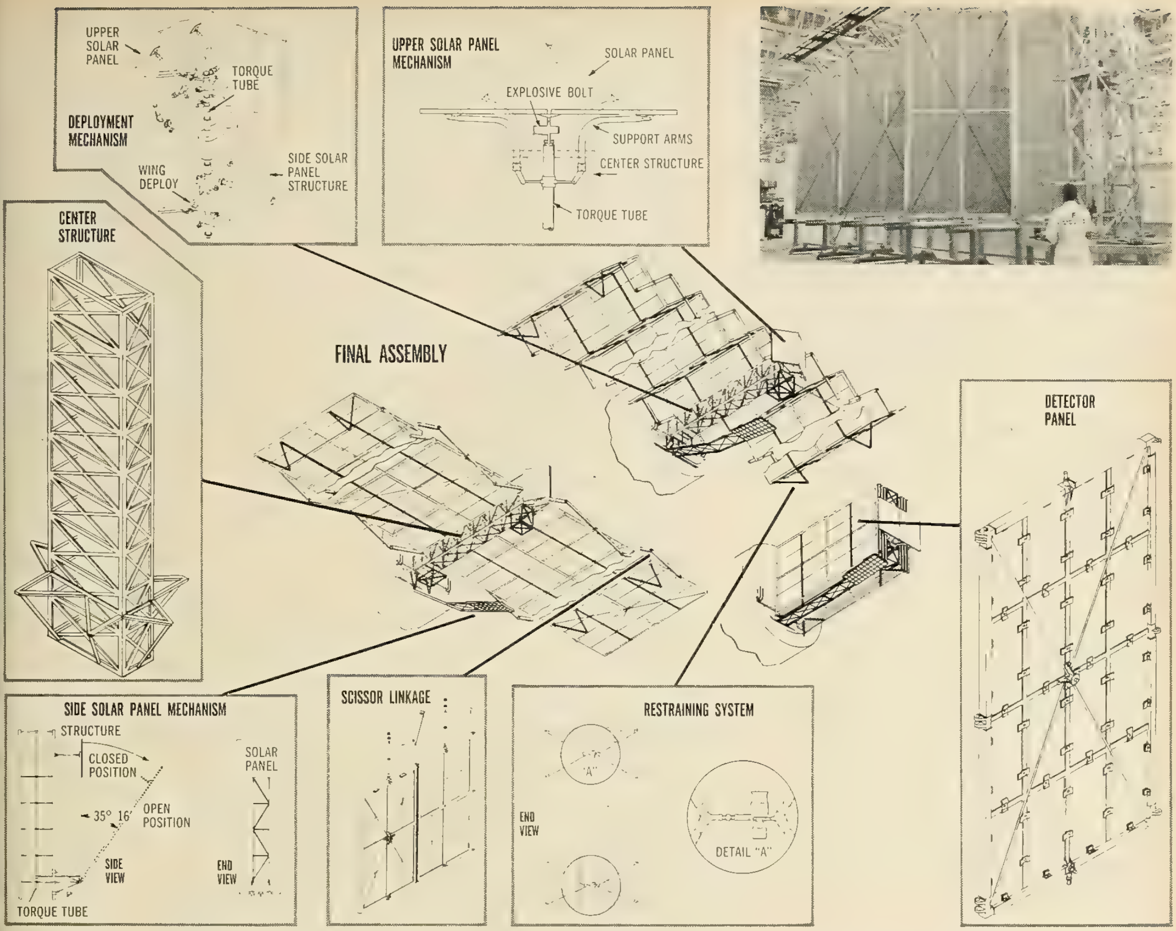
Torque tubes, which provide power to extend the wing linkage, also erect the four solar-cell panels and the antenna. Two solar panels are hinged at the upper or forward end of the center structure. Two individual panels are boom-mounted and are rotated outward from the sides of the structure.

A crossed-dipole antenna is boom-mounted and is extended 10 ft. beyond the forward end of the satellite structure.

When the spring-scissors extensio mechanism is employed, the solar panel and the telemetry antenna will be deployed simultaneously from the cente structure.

The center structure will be connected to the service module by mean of an adapter. Five electronic subsystems contained within the cente structure will provide for communications, data handling and timing, attitude sensing, meteoroid-hit detectio and electrical power.

Each wing is comprised of 6½ detection sections. When deployed, sections will be outstretched in a singl plane parallel to the thrust axis of th S-IV stage.



METEOROID DETECTION SATELLITE (p. 32), due to be launched in middle of next year, will weigh about 3,400 lbs. and have a "wingspan" of more than 100 ft. Massive detector sections will be extended (photo and drawings above) by spring-scissor mechanical linkage. Wings, solar panels and antenna will be deployed in one minute. Two will be orbited.

- **Impact surface**—Fairchild studies indicated that three general types of detection structures could best be employed—flat or V-shaped wing, twisted wing, or parasol.

The twisted wing was determined to be the best, since it offered a target regardless of spatial orientation; however, its use was impractical within the development time frame.

The flat wing was selected, according to the company, because it offered vastly simpler construction than the parasol and greater reliability, particularly with respect to deployment. Finally, the flat wing, with its more conventional extension mechanism, required less critical tolerances and is generally easier to manufacture.

- **Panel assemblies**—The wing extension mechanism employs scissor linkage driven by a torque tube connected between hinge joints. Positive locking produces necessary wing rigidity when the structure is fully deployed.

Each detector section contains 16 detector panels, measuring 20 x 40 in. Each panel is made up of two aluminum-alloy/aluminized mylar capacitor sheets separated by a 1-in.-thick foamed core. A total of 392 test detectors is provided.

Core density was optimized at 4 lbs./cu. ft. (to meet a NASA requirement that only 1 in 10,000 particles penetrating one detector would produce debris impacting on the oppositely located detector).

Detector panels are bound in extruded rubber and window-frame mounted in aluminum alloy.

In operation, the capacitors will be charged with 10 volts. The detection system is designed so that open or short failures of individual test panels will be pinpointed and disengaged on command. Short-circuit detection is passive; open circuits are located through parallel wiring.

Discharge and charge currents are noted, as well as the time interval measured after each meteoroid hit, to assure impact detection rather than spurious signals.

Open and short tests will not interfere with acquisition of penetration data even if failure occurs in test circuitry.

When a test sheet is penetrated by a meteoroid, the capacitor is discharged, primarily through a plasma formation in the hole produced by the very high velocity impact. After discharge, according to Fairchild scientists, the plasma dissipates and the detector becomes recharged.

Intermittent or permanent short circuits may occur within the puncture region due to several causes: spalling of the test sheet, dielectric breakdown, or vapor deposition of the aluminum around the puncture. Also, thermal cycling may create or contribute to intermittent short or open circuits, the scientists claim.

All circuits carrying hit data from the panels will be of flat ribbon multiconductor printed cable to minimize crosstalk and telemetry interference. ■

Mercury Missions Seen More Useful Than Mars, Venus Probes

Planet's unique 'deep freeze' dark side might be greatest source of light elements in inner solar system; more launch windows available

by Dandridge M. Cole
General Electric
Missiles and Space Division

THE PLANET MERCURY has somehow largely escaped attention as an object of exploration in the U.S. astronautical program, which at present is confined entirely to unmanned exploration of near Earth space, the Moon, Mars and Venus, and manned trips to the Moon.

Apparently the principal reason for the neglect of Mercury is a widely held misconception of the relative difficulty of flights to that planet. As a matter of fact, the problems of Mercury flights, in terms of velocity requirements, are of the same order as those involved in flights to the Moon, Mars and Venus. They fall well below the requirements for trips to the major planets in our solar system.

There are five or six classes of astronautical objectives which may reasonably be included within the technological limitations of the 1960's and 1970's. They are, in order of average difficulty for various types of trips: the Moon, Mars, the close-approach asteroids and comets (M/R, Feb. 25, p. 43 and M/R, May 6, p. 22), Mercury, Venus, and possibly Jupiter. By a strange quirk of fate, it was Venus which yielded the first new scientific data to a U.S. space probe.

- **Why Mercury?**—Mercury is at least as interesting as the other astronautical objectives listed. In some respects it is of unique interest.

It has been concluded by some scientists that the dark side of Mercury, which is never exposed to solar heating, is the coldest spot in the solar system. The very tenuous atmosphere would serve as an ineffective medium for convective transfer of heat from the hot side.

Mercury is the only planet in the solar system exhibiting this behavior. Even by traveling all the way to Pluto we could not investigate the characteristics and effects of such a giant "deep freeze".

Because of this "deep freeze" and a surface gravity approximating that of Mars, it is possible that the dark side of Mercury represents the greatest storehouse of light elements in the inner solar system (outside the Earth). This would have great significance for the logistic supply of future manned bases or colonies as well as its basic scientific interest. Important discoveries might also result from the permanent shielding of the cold side from types of solar radiation other than thermal.

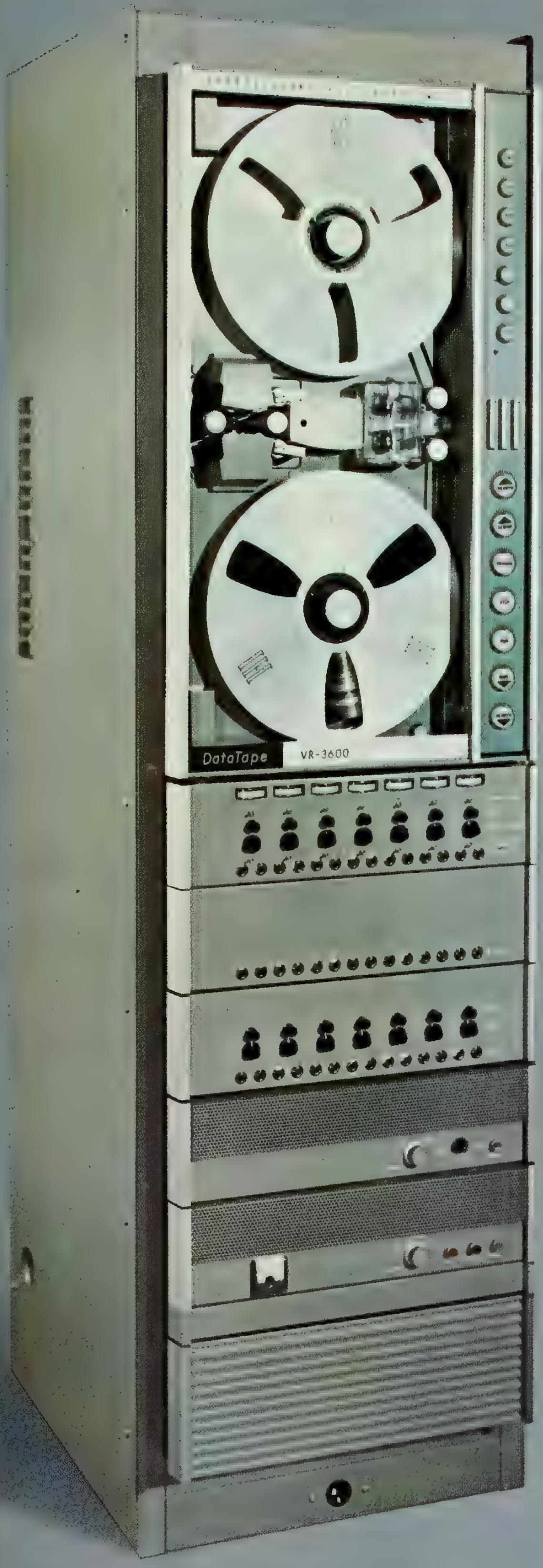
FEASIBILITY	TARGET					
	LOW ORBIT	MOON	MARS	VENUS	MERCURY	EROS GROUP
Bases	1960's	1970's	1980's	....	1980's	1980's
Launch Windows	Frequent	Frequent	26 mos.	18 mos.	4 mos.	Frequent
Fly-by Velocities Feet per Second	30,000	40,000	43,000	42,000	46,000	42,000
Soft Landing Velocities	(Rendezvous) 31,000	49,000	45,000	44,000	48,000	45,000
Return Velocity	1,000	9,000	21,000	39,000	32,000	4,000
Round-Trip Velocities	32,000	58,000	66,000	83,000	80,000	49,000

The hot side of Mercury undoubtedly includes the hottest solid surfaces on any of the planets, as well as possible large accumulations of hot liquids that could not exist in the molten state anywhere else in the solar system. Unusual effects might also have resulted from constant exposure to other forms of high-intensity solar radiation.

The twilight zone of Mercury is also unique in the solar system and could contain many surprises for our scientists. Because the orbit is quite elliptical and the spin rate is constant, an apparent wobbling occurs with respect to the direction of the Sun. Thus, some 40% of the area of the planet passes through alternate light and dark periods comprising a "day" of 88 Earth days in length. This is somewhat similar to the situation at high latitudes on the Moon, where the "day" is 28 days long and the Sun never rises high in the sky.

The twilight zone of Mercury is of particular interest because of the cyclic changes in temperature, the moderate average temperature (particularly a few feet below the surface), and the possibility that in past ages—if not now—frozen gases from the cold side were melted during the periodic warm spells and formed both liquid water and an atmosphere of light gases.

Since this appears to be a good description of a pre-biotic environment (atmosphere, solar energy, liquid water.



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For *all* specifications, contact your local CEC sales representative, or write for Bulletin 3600-S.

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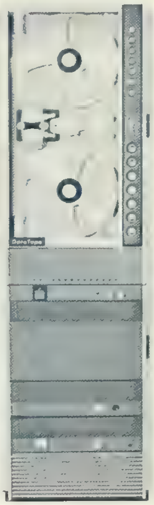
PR-3300 combines low cost and portability with excellent performance. The complete 14-channel record and reproduce system can be unitized as a single portable system 29⅞ inches high weighing no more than 213 pounds. Direct, FM, or PDM techniques can be used singly or combined. CEC Bulletin 3300S.

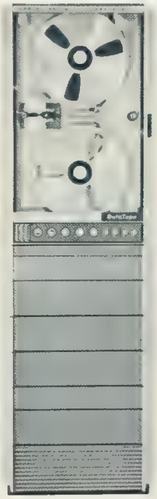
VR-3300 is a wide band system for use in applications where portability is desirable. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques — or twice the bandwidth of standard telemetry records. Features include 6 speeds and all solid state electronics. Bulletin 3300VS.

DR-2700 is a high speed Vacuum-Buffered Digital Magnetic Tape System designed for on-line and off-line digital computer usage. A complete 16-channel digital write and read system can be housed in the unit's 72-inch-high RETMA cabinet. Outstanding reliability has been proven in critical military applications and in IBM compatible installations. Bulletin 2700S.

GR-2800 is solid state, a fully integrated recorder/reproducer system. A single standard 19-inch EMA rack with a 64-inch-high opening contains the complete 14-channel record and reproduce system. The one cabinet can mount 28 amplifiers (operating in Direct, FM or PDM modes), capstan power amplifier, and tape-speed control servo. Direct record response is 100 cps to 100 kc; FM response is 0-10 kc. Bulletin 2800S.



VR-2600 is an advanced design, multi channel wide band data recording and reproducing system designed to handle precision data in the frequency spectrum from d-c to 600 kc. Record and playback amplifiers in the 14-channel system can handle Direct, FM, and PDM data. 16 track PCM techniques can also be supplied. Bulletin 2600S.



VR-2800 is a wide band system for use in laboratory environments with Direct and FM electronics. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques. The full 7- or 14-channel system, with 6 speed operation and plug-in electronics, can be packaged in a single, six-foot EMA cabinet. Bulletin 2800VS.

CEC Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of **Bell & Howell** • Pasadena, California moderate temperature), the possibility that life might have evolved there should not be excluded. The possibility that a migratory type of life developed in the twilight zone and follows the Sun in such a way that only the optimum percentage of the solar disk is visible is an example of the type of exciting discovery that could be made in this unusual environment.

Note that the terminator (line between day and night) velocity is about 1.5 miles per hour; forms of life similar to Earth animals could maintain the average migration velocity required to hold the desired distance from the terminator. Presumably, Mercurian life would have to be of the encapsulated, closed-cycle, symbiotic form rather than the open-cycle Earth form.

- **Comparative feasibility** — Two major aspects of the exploration of Mercury have received litttle or no attention in the very brief consideration generally given to this fascinating planet. One is the possibility of finding large quantities of frozen light elements (particularly the "life" elements—carbon, oxygen, hydrogen and nitrogen) on the dark side. The other is the possible value of even a tenuous atmosphere in decelerating a spacecraft prior to landing.

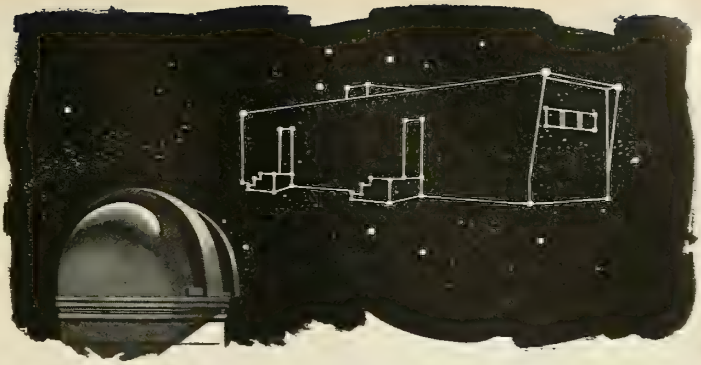
Because little is known positively about the atmospheric pressure on Mercury—except that it must be very low, even compared to that of Mars—it is generally assumed to be of no practical consequence in relation to space flight. This may not be the case.

Estimates by Dollfus of the atmospheric pressure at the surface of Mercury lead to a value of one to three millibars, corresponding to the pressure at Earth altitudes of 130,000 to 150,000 ft. While this might be considered essentially a vacuum for most practical purposes, it could play a significant role in the deceleration of spacecraft.

Vehicles re-entering Earth's atmosphere undergo most of their deceleration above 200,000 ft. (even the relatively high-density capsules recovered to date). Because of the low gravity of Mercury, the atmospheric density would change more gradually with altitude than for the Earth. There should be a cross-over point at some distance from the planet where the density would be higher than for a corresponding distance from the Earth.

Consequently, re-entry deceleration could be more gradual, with lower peaks in the deceleration and heating curves. Thus, we should consider the possibility of atmospheric braking for Mercury landing spacecraft, manned or unmanned, at least until better data can be obtained on the properties and extent of the atmosphere.

The accompanying table includes total velocity change requirements for



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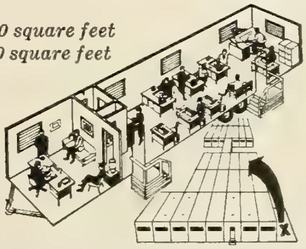

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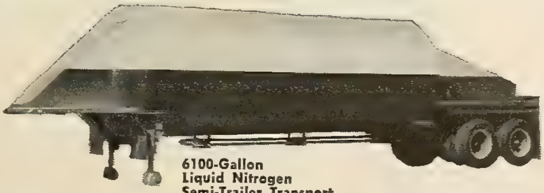

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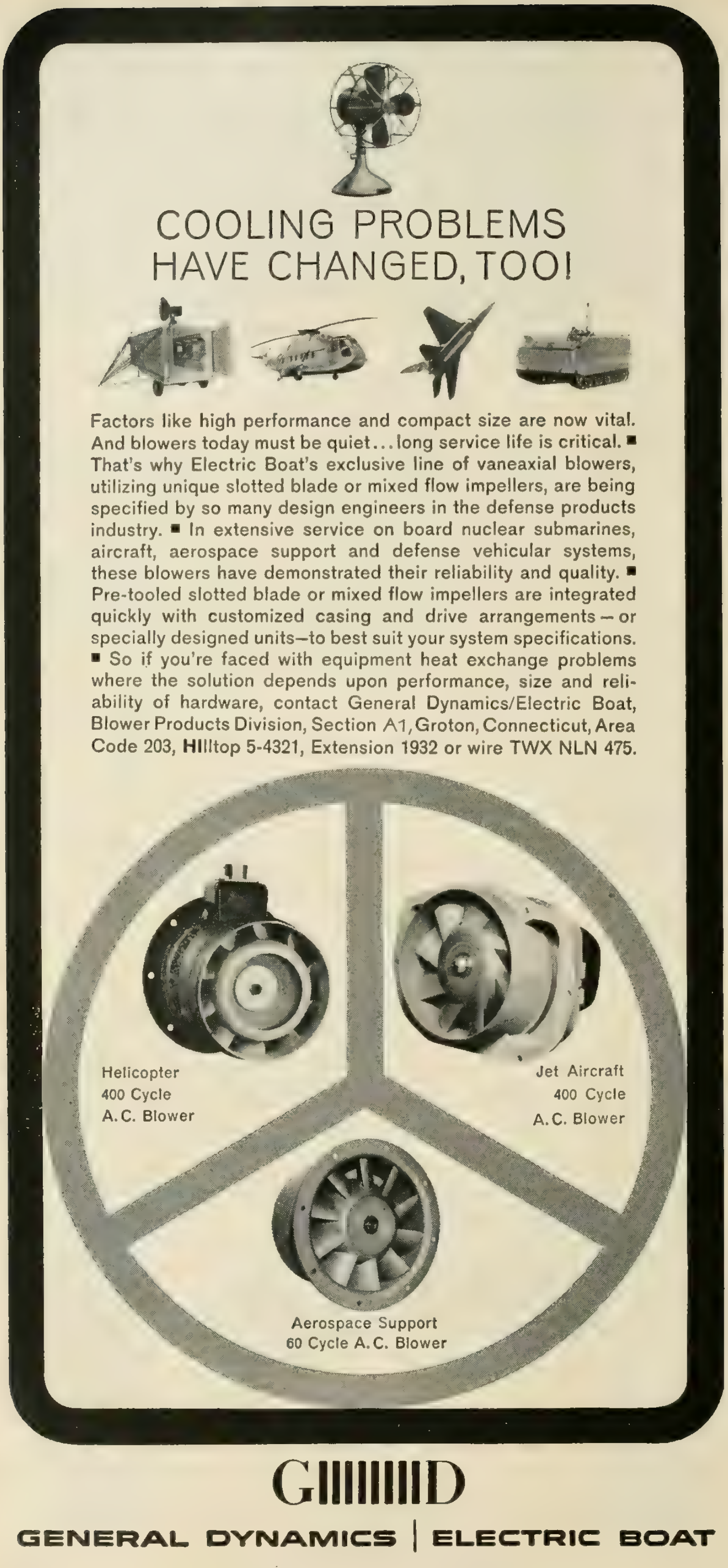

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Factors like high performance and compact size are now vital. And blowers today must be quiet... long service life is critical. ■ That's why Electric Boat's exclusive line of vaneaxial blowers, utilizing unique slotted blade or mixed flow impellers, are being specified by so many design engineers in the defense products industry. ■ In extensive service on board nuclear submarines, aircraft, aerospace support and defense vehicular systems, these blowers have demonstrated their reliability and quality. ■ Pre-tooled slotted blade or mixed flow impellers are integrated quickly with customized casing and drive arrangements—or specially designed units—to best suit your system specifications. ■ So if you're faced with equipment heat exchange problems where the solution depends upon performance, size and reliability of hardware, contact General Dynamics/Electric Boat, Blower Products Division, Section A1, Groton, Connecticut, Area Code 203, HIlltop 5-4321, Extension 1932 or wire TWX NLN 475.

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various astronautical objectives in the inner solar system. Four missions are considered for both manned and unmanned vehicles.

- **Fly-by**—It should be noted that the propulsion requirements (total velocity change) for missions beyond Earth orbit involving fly-by probes, such as the *Mariner II* Venus probe, range from 40,000 to 46,000 fps and involve only secondary differences. Thus, other factors—such as guidance, time in space, communication distance, and launch window availability—should be considered.

However, these factors also are found to involve the same general degree of difficulty (with the exception of the Moon) except for the question of availability of launch windows. Here Mercury is highly favored, since launches could occur several times a year compared to every 18 months for Venus and 26 months for Mars.

In addition to the single-planet fly-by trips indicated in the table, a number of studies have been made of possible Mars-Venus fly-bys, particularly in the 1970-1980 period. However, no studies have been publicized of the equally interesting Venus-Mercury or Mars-Mercury two-planet fly-bys, and the possibility of a three-planet fly-by. Such trips would potentially provide two or three times the data from a single fly-by, with only slightly greater velocity, hardware, and flight time investments.

Total velocities for soft landings again are spread through a small range, from 45,000 for Mars and Venus to 49,000 fps for the Moon.

It is in the return velocities that the large differences occur. This would be of major importance for manned exploratory vehicles, but possibily of considerably less importance during the later phase of manned bases or colonies. A more important question in the later base-colony phase might well be the availability of sources of rocket propellants. It might well be that the cold side of Mercury would be a better source of propellants than could be found on either the Moon or Mars.

We still know too little about Venus to decide definitely against ever establishing manned bases on its surface. However, we note in the table that the return and round trip velocity requirements are greater for Venus than for Mercury because of the higher escape velocity of the former.

For the total round trip velocity required, Mercury falls between Mars and Venus. Considering the other factors discussed here, including the fascinating possibilities connected with the twilight zone, Mercury should place higher on the list of astronautical priorities than Venus and almost as high as Mars. ■

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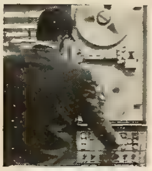
What 1.5 mc recorder has two signal-to-noise ratios? AMPEX FR-1400

Take your pick: signal-to-noise ratio of 20 db or over 30 db. Ampex quotes 20 db. Measured performance averages out to be several db better. But these figures are meaningless without knowledge of the framework within which they are derived. Ampex determines signal-to-noise ratio by recording a 1 kc sine wave at 1 volt with the recorder set to give 1% maximum distortion over a bandwidth of 400 cps to 1.5 mc. Among other ways to measure signal-to-noise ratio, one is by recording a square wave at peak signal level; measured this way the FR-1400 has a signal-to-noise ratio in excess of 30 db. Ampex prefers the sine wave: it's harder to record and gives a truer measure of signal performance. That's Ampex policy. All Ampex specifications represent minimum performance. And, too, all represent the critical relationship of one function to another as they react upon one another. This is also true in those new areas of specification necessary to evaluate wider bandwidth recorders: envelope delay, phase response, intermodulation distortion products. For information defining Ampex's measuring techniques write for the Ampex Technical Information Bulletin Series: Ampex Corporation, Redwood City, California. Worldwide sales and service.



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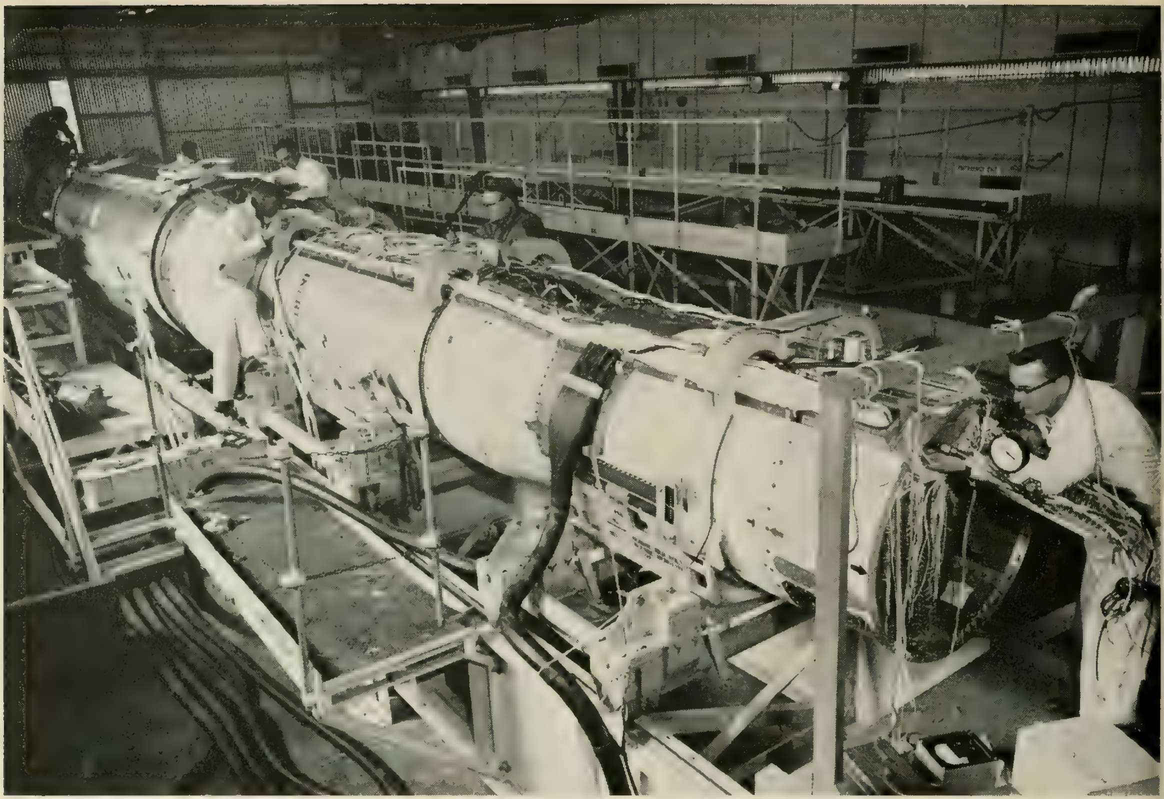


BOEING TECHNICIANS install instrumentation in Minuteman. Firm has an ambitious cost-cutting program on the ICBM.

Minuteman Cost-Cutting Aims Outlined

Boeing, suppliers, hope to trim $60 million from FY '64 expenditures on program; cost-reduction committee established

by Robert Twiss

HOW MUCH *Minuteman* business volume could The Boeing Co. add by a superior performance in assembling and deploying the nuclear-tipped ICBM's?

T. A. Wilson, Boeing vice president in charge of the key missile program, has estimated an outstanding Boeing effort could add from $200 to $400 million a year in business volume from 1964 to 1967.

The Air Force has said it costs about $3.5 million for each war-ready *Minuteman* in its launching silo.

"If the cost could be reduced, the program could become even more attractive to the cost-conscious Department of Defense," Wilson explained. Wilson thinks Boeing and other associate contractors in the program can expect substantial *Minuteman* volume into 1967, on the basis of announced DOD deployment plans for *Minuteman.*

- **Efficiency necessary**—The Boeing executive cautioned, however, that efficiency of the contractors will determine the volume. Recalling the cancellation of the *Skybolt* air-launched ballistic missile, Wilson pointed out that DOD has no hesitation in cutting out or reducing programs where cost estimates continue to climb.

Wilson, Air Force officials and executives of other firms in the program, have no intention of letting costs spiral. Actually, at the suggestion of Maj. Gen. W. Austin Davis, ballistic systems division commander, Boeing and its suppliers have embarked on a cost-cutting program to trim $60 million from Fiscal-Year 1964 expenditures.

Wilson describes the cost-reduction program as a "formally organized effort to bring about significant reductions in *Minuteman* costs, with specific emphasis on our inplant and field operations, plus our suppliers."

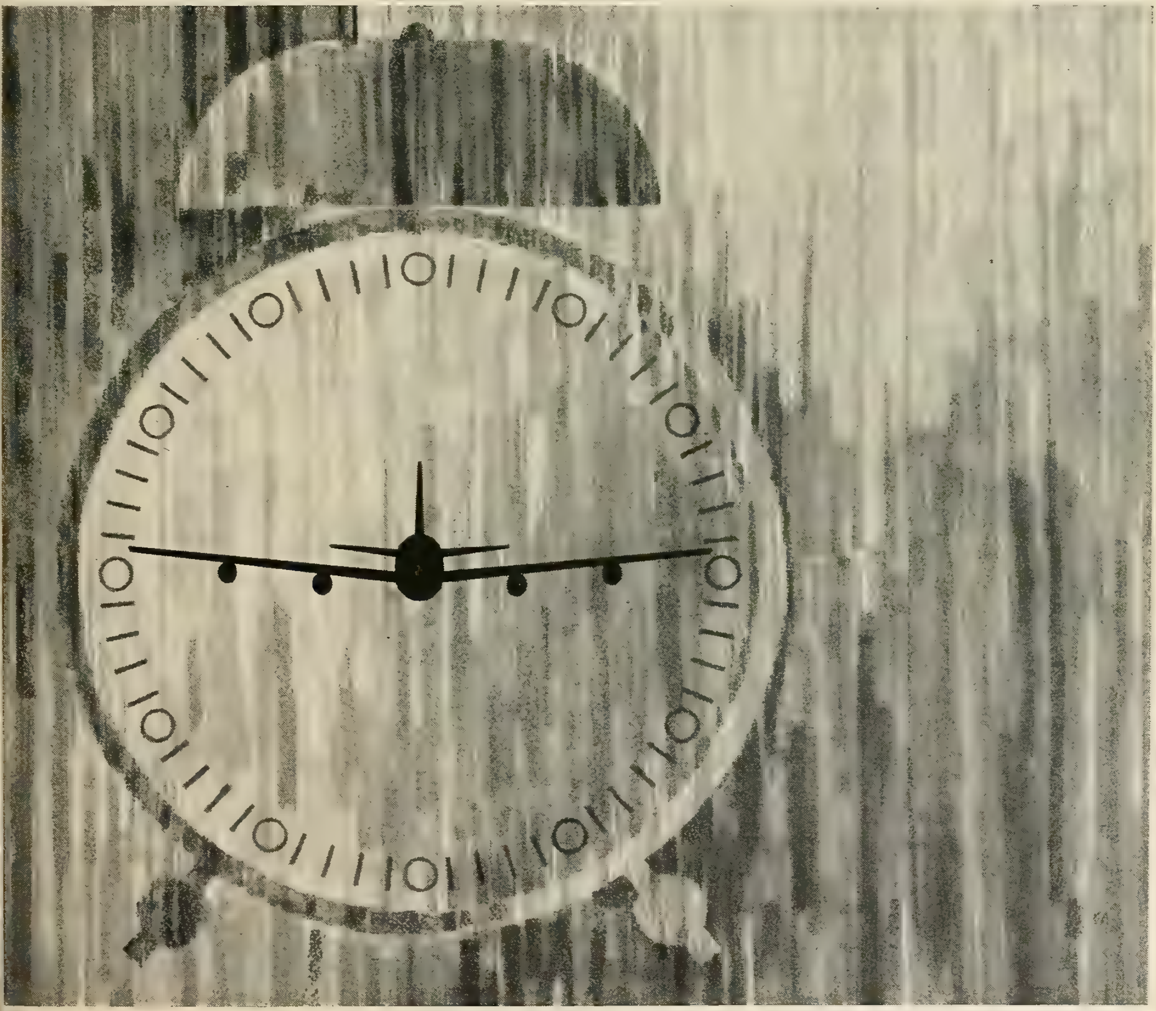
- **Cost reduction committee**—"Direction of the program will be by a *Minuteman* cost reduction committee, composed of members from throughout the *Minuteman* branch (of the Boeing aerospace division). William R. Owens has been appointed cost reduction manager."

The committee is comprised of a representative from every *Minuteman*

SLEEPING GIANT

...AND WHAT DOUGLAS IS DOING ABOUT IT

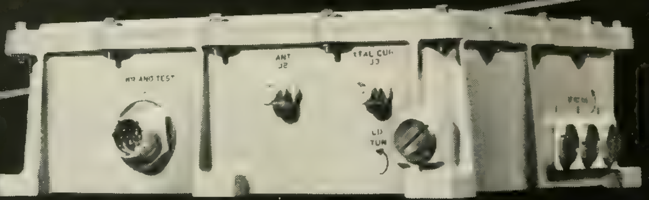
Freight-to-passenger ratio for airlines gives strong evidence of following railroad patterns. Fifty years showed freight increasing from 20% to 88% of total railroad business. Cargo by air has grown from 3% to 9% in the past fifteen years. Freight-by-air is a sleeping giant which could awaken with a roar as a result of important shipping economies being made possible by the new Douglas jet freighters now entering service. □ And Douglas is helping awaken the giant on several other fronts. These include coordinating a study of freight movement statistics in conjunction with several major airlines; designing improved terminals and cargo handling systems; analysis of terminal-to-terminal control; and, of course, continuing production of jets with lowest possible operating costs.



Douglas research programs involve 23 technological areas relating to aerospace and defense systems. Major Douglas divisions are located in Santa Monica and Long Beach, California; Tulsa, Oklahoma; and Charlotte, North Carolina.

DOUGLAS

USED



TRANSPONDERS

PROVEN RELIABILITY IN ACTUAL USE makes Motorola radar transponders the logical choice for critical tracking, data and control missions. Case in point...AN/DPN-66 (Motorola SST-102A) illustrated above, **USED ON SATURN, PERSHING** and over 15 other current aerospace programs. A precision C-band unit, weighs 10.8 lbs., occupies 200 cu. in., it is just one of a complete line of transponders ready for fast, off-the-shelf delivery. Others include: **USED ON SCOUT, ATHENA** and at **WSMR** SST-131, this transponder is an extremely rugged microminiature superheterodyne unit, weighs only 3 lbs. and occupies just 40 cu. in., qualified for high-thrust, solid propellant boosters. Power: 400 watts. Sensitivity: —65 dbm. **USED AT AFMTC** AN/DPN-71, a high-power, superheterodyne unit for deep-space tracking assignments. Power: 20 kw. Sensitivity: —75 dbm. **USED ON SATURN,** and **PERSHING** AN/DRN-11, UDOP (UHF Doppler) transponder provides extreme range and position accuracy for ballistic vehicles. Power: 3 watts (15-watt power amplifier optional). Sensitivity: 5 microvolts. **USED ON NAVY AIRCRAFT** AN/APN-132, an X-band transponder with 5 channel decoder. Power: 100 watts. Sensitivity: —65 dbm. For full performance specifications, or modification data to meet other parameters, write our Instrumentation Products Group.

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branch organization. These representatives, in turn, will head up cost reduction efforts in their own organization.

"To illustrate how vigorous this program will be, each organization will have its own target of cost reductions," Wilson said. "In order to attain this, each segment of each organization will have to analyze and evaluate every step of its operation."

Wilson thinks the program, if its goal is reached, can accomplish a great deal.

- **Four goals**—"In the first place, we will strengthen our competitive position, both in the area of what the final product costs the customer and the area of management capability. Second, through low-cost performance, we will enhance the ability of the (aerospace) division to acquire new business.

"Third, by achieving minimum costs on both fixed fee and incentive type contracts, we will increase our earnings, and, fourth, we can give our customer real assistance in budget forecasting and in achieving a minimum system cost for the entire program."

- **Continuing effort**—The cost reduction program will not be just a one-year effort, Wilson emphasized.

"We will continue to seek ways to improve our performance and keep costs down for the life of the program, which will extend for several years," he said. A second cost-reduction conference, similar to the one held in Seattle recently, is planned for a year from now to announce results as well as plans for continuing cost-reduction activities.

Suppliers, Wilson said, have highly important roles. The suppliers will conduct cost reduction activities in their own plants similar to the program at Boeing.

"We have developed a system to insure smooth meshing of supplier efforts with those of our own," he said.

William M. Allen, Boeing Co. president, commenting on the cost reduction conference which kicked off the ambitious savings program, said:

"In my view, the purpose of this conference goes to the root of one of the most important problems confronting this country today, namely, how efficient can we be in the face of the competition that confronts us, both in the unfriendly part of the world and the free world as well?"

Allen said that "certainly one of the great challenges confronting this country today is this: Are we able to meet, from an economic standpoint, the competition with which we are faced in the rest of the world?

"Upon our ability to meet successfully this competition rests the future destiny of our nation, and, in my opinion, this challenge is no less acute in the case of a *Minuteman* weapon system than is involved with a commercial product."

Allen said that it "is well that increased attention is being focused on many fronts on the achievement of greater efficiency in the defense industry. We continue to pay higher and higher wages, and if these increased costs are not offset by increases in productivity, we will continue either to reduce the amount of defense the country is able to buy or increase the required size of the defense budget."

Allen said that "at this point in time, I feel that we are losing rather than gaining ground" in meeting "the competitive forces with which we are faced."

Wilson said Boeing had been in touch with the Martin Co. on its *Titan* cost-reduction program, "and they have been most helpful in the development of our program."

The $60-million savings goal for Fiscal '64 is against the most "recent projected expenditures for Fiscal Year 1964," Wilson said. "The total is divided between Boeing and the suppliers in the amounts of $44 million and $16 million, respectively."

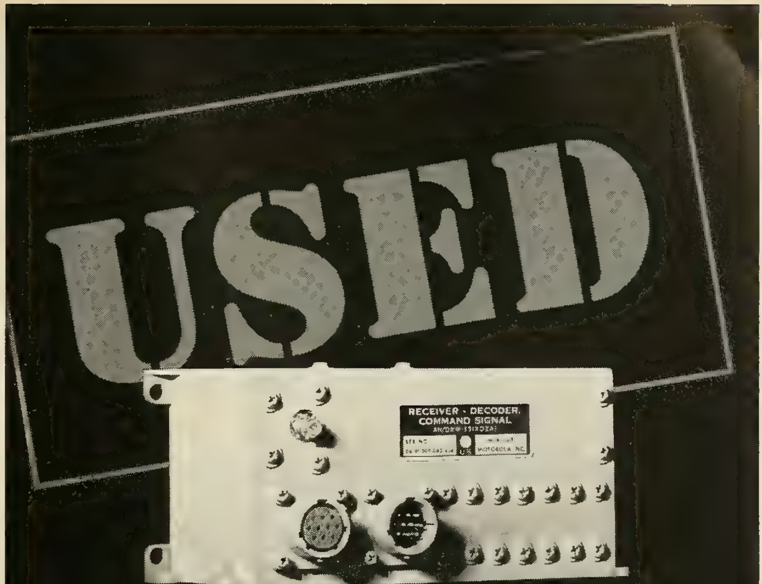
Recognizing the importance of supplier contributions, the Boeing cost committee developed a streamlined processing system to assure a fast appraisal of supplier suggestions. A second innovation is a special task force to help suppliers cut costs.

- **Sample savings**—Examples of savings accomplished in fiscal 1963, without the increased emphasis on cost-cutting, included a variety of items. More than $76,000 was saved by eliminating serial numbers from each part of a certain *Minuteman* component and reducing accompanying paperwork from 102 to two pages a unit. About $1,100 was saved through a manufacturing employe's suggestion that inexpensive mold castings instead of sandcastings be used in producing parts for a type of ground-support-equipment cabinet.

Housing for personnel assigned to remote *Minuteman* installations provides another example. Savings of nearly $200,000 were realized by remodeling vacant barracks at one *Minuteman* wing site instead of building units similar to those used where housing is unavailable.

To encourage suppliers to develop similar savings items, Boeing plans to negotiate value-engineering clauses into purchase orders which offer significant cost reductions. This share-the-rewards policy promises to be a stimulant for active participation by suppliers.

The goal of the drive, of course, is to reduce *Minuteman* costs, but not at the expense of schedules or performance. In *Minuteman*, effectiveness is a primary consideration. ■



COMMAND RECEIVERS

PROVEN RELIABILITY IN ACTUAL USE has made Motorola command receivers the most widely specified command instrumentation today for advanced aerospace functions. These compact FM receivers deliver a threshold sensitivity of 5 microvolts over a full temperature range of —54° C to +71° C, and have been fully qualified to other extreme environmental requirements of the most rigorous missile and space applications. They can also be supplied with a complete selection of tone channels from 0 to 20. For example...**USED ON SATURN,** Motorola Model MCR-101, shown in illustration above, provides 10 channels, weighs only 2 lbs., 15 oz. **USED ON AGENA** MCR-307, the smallest, lightest 3-channel unit made, weighs but 2 lbs. **USED ON POLARIS** MCR-312, features an isolated ground system, supplies 3 decoder channels, weighs 3 lbs. **USED ON MINUTEMAN** MCR-403, contains 4 decoder channels, weighs 3 lbs., 13 oz. **USED ON MERCURY** MCR-102/MAD-101, receiver-decoder combination, provides a 20 channel system, weighs but 5 lbs. Standard 3- and 10-channel receivers are available for fast, off-the-shelf delivery. For full performance specifications, or modification data to meet other parameters, write our Instrumentation Products Group today.

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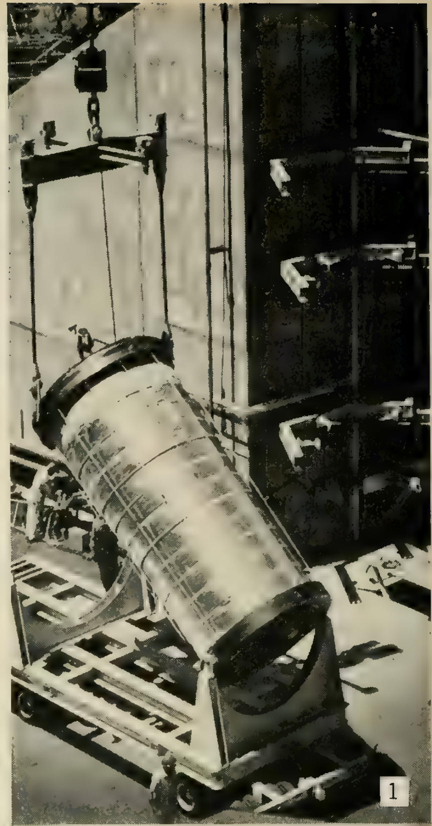
STATE-OF-THE-ART REPORT ON SOLID PROPELLANT ROCKET MOTOR DEVELOPMENT AT UTC

Dramatic refinements in solid rocket motor technology during the past few years have greatly increased their usefulness. High-performance solid propellants, segmented motors, extended duration nozzles, thrust vector control, lightweight fiberglass casings, and simultaneous ignition of solid propellant clusters have all been successfully demonstrated — in the past 18 months — at United Technology Center. Current rocket motor programs at UTC apply the simplicity and reliability of these improved motors to such uses as giant boosters, upper-stage components, retro- and sounding rockets, and "hi-G" assignments for anti-missile weaponry.

- UTC pioneered the concept of large segmented solid propellant booster motors, and is prime contractor for the first stage of USAF Titan III C, the Standardized Space Launch Vehicle. Together, the two 120-inch segmented solid propellant motors which make up this booster stage will generate lift-off thrust of over 2 million pounds — more than 80% of the vehicle's total thrust. Identical motors, fired in larger clusters, could achieve the very large lift-off capability required for any space mission now planned for this decade.
- Research and development programs at UTC — company funded and contractual — cover a broad spectrum of propulsion: solid and storable liquid propellant rockets, and hybrids.

The company's facilities, production capacity, organizational experience, and backup by United Aircraft Corporation equip United Technology Center to handle a variety of advanced propulsion assignments.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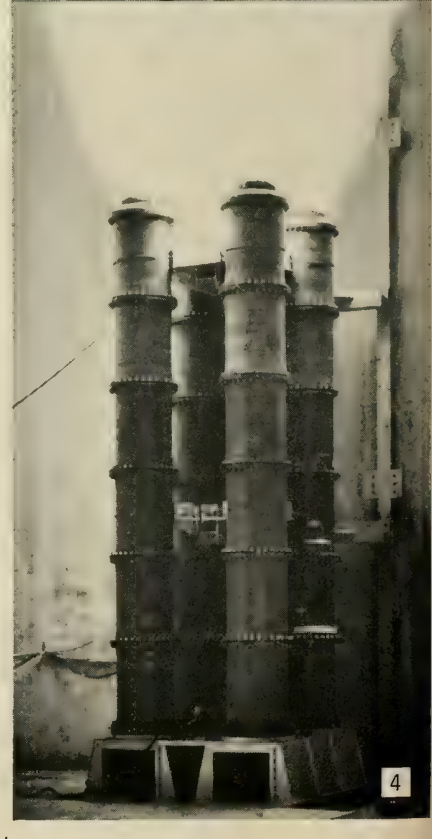
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UNITED TECHNOLOGY CENTER

DIVISION OF UNITED AIRCRAFT CORPORATION

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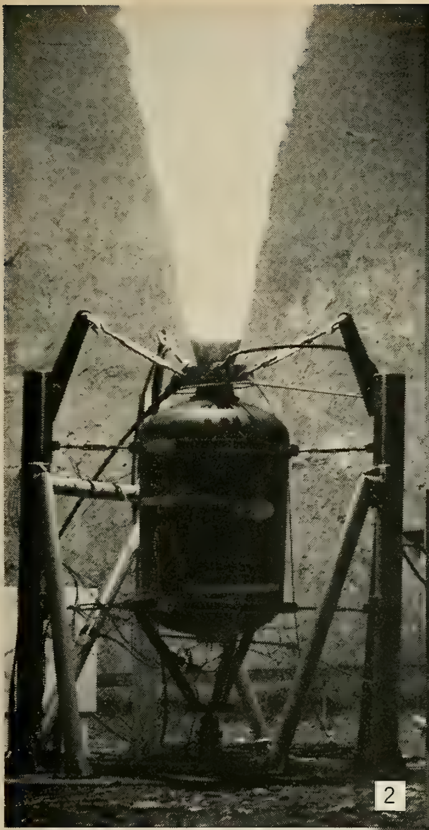
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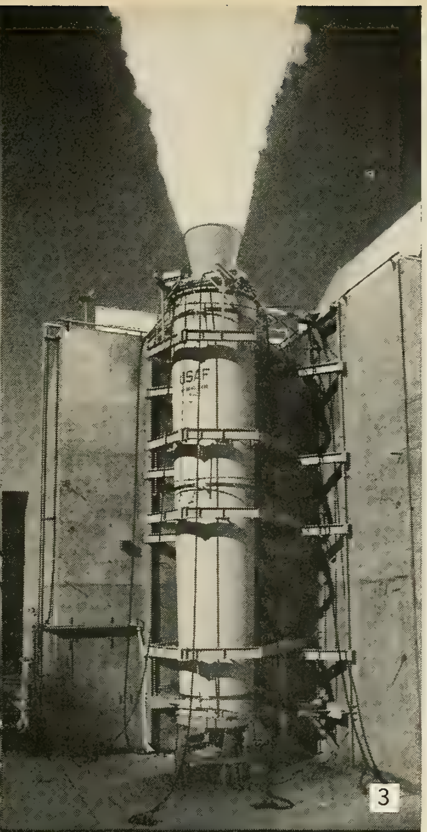

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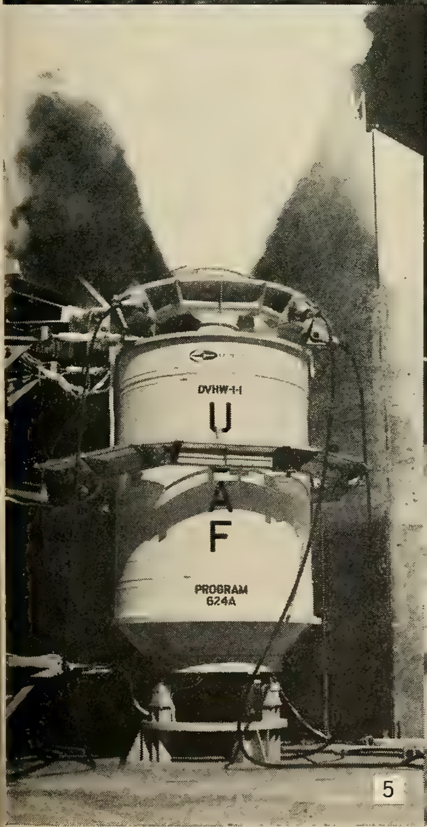

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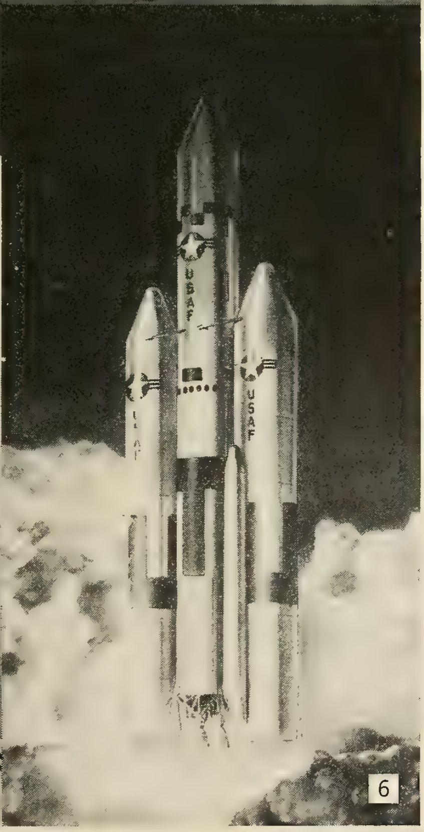

6

1. Segmented solid rocket motor. The concept of large, segmented, solid propellant boosters, first advanced by UTC in 1958, has been brought to reality at the company's Coyote development center. Here, giant test bays have capacities up to 4,000,000 pounds of thrust.

2. Early feasibility test firings demonstrated the efficiency of UTC's unique clevis joint, key to the development of reliable segmented solid propellant rockets. Subsequent tests included the nation's first practical segmented fiberglass cased motors.

3. Company Funded R & D overcame intitial problems of large segmented solid propellant boosters: core design, exit nozzles, and thrust vector control. Test of USAF 35-ton motor verified UTC's preliminary results.

4. Clustered Solid Propellant Motors fired by UTC demonstrated simultaneity of ignition far exceeding manned launch specifications. Clusters of large solids can provide tens of millions of pounds thrust.

5. First 120-Inch Motor fired under USAF Program 624A produced peak thrust of 250,000 pounds during two-minute firing. Single-segmented test is first step in UTC's Titan III C development program.

6. USAF Titan III C. The first stage of this Standardized Space Launch Vehicle, consisting of two five-segment solid propellant rocket motors, 120 inches in diameter, will give this vehicle more than 2 million pounds of thrust at lift-off. It will orbit multi-ton payloads to low and medium altitudes.

WHY A STRAP-DOWN INERTIAL SYSTEM? BECAUSE it conserves space, weight and dollars...and is readil adaptable to advanced sensors. It is inherently free from "gimbal-lock." The STRAP-DOWN syster developed under sponsorship of Aeronautical Systems Division, AFSC, USAF, offe the added advantages of the extreme reliability proven in solid-state computers. A graphically demonstrated above, the strap-down system has freedom of form factor. Ours is th one company comprehensively qualified to handle advanced assignments in this field, from in tial concept to production. **FORD INSTRUMENT CO.** ☐ DIVISION OF SPERRY RAND CORPORATIO

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Tapco Producing Saturn Attitude-Control Rockets

Parallel series valve configuration developed by firm to reduce failures; tests show high combustion efficiency

PROTOTYPE of 150-lb-thrust attitude-control rockets for the Saturn S-IVB stage.

A PARALLEL-SERIES configuration of four valves for each propellant of the *Saturn* S-IVB stage attitude-control rockets is being developed by Tapco Division of Thompson Ramo Wooldridge Inc.

The Cleveland firm is under contract to Douglas Aircraft Co. to build the ablatively cooled, 150-lb.-thrust units for the *Saturn* third stage.

Use of the parallel-series concept in valving—four valves for each propellant, eight in all—means that to cause valve package failure, two valves must either fail to open in parallel or two fail to close in series.

In addition, the rapid pulse unit includes:

—A tube type injector producing multiple unlike-on-unlike impinging doublets.

—A single coaxial oxidizer and fuel solenoid valves of hard seat design.

—An ablative liner design using random-oriented silica reinforced phenolic resins.

—A hard throat insert consisting of oxidation-resistant coated refractory materials.

An engine of 150-lb. nominal vacuum thrust rating using nitrogen tetroxide and a 50-50 mixture of UDMH and hydrazine has been subjected to life cycle tests identical to that required for the S-IVB mission.

Tapco scientists have operated the unit over 20 minutes with characteristic velocities exceeding 5,300 fps—indicating a high combustion efficiency level.

Two "quad-redundant" valve package concepts are in development for the system. Each valve is independently solenoid-actuated and uses a soft seat exhibiting a maximum leaking rate less than 0.5 cm per day.

Power consumption will not exceed 28 watts per coil at a 28-volt supply rate. The response will be approximately 18 milliseconds to full-open after signal initiation.

One design approach is a quasi-piloted design. The pilot seat is opened by the solenoid armature reducing the main valve seat loading in the closed position. A seat of large seating area can be opened with a small magnetic force without expending energy from any outside source.

The other design approach involves the use of a valve-seat plunger configuration optimized to reduce static seat loadings. The armature pulls directly on the valve seat. Only one static external seal is required in either approach.

The static pressure drop is 25 psia maximum for either valve package with only one leg of the parallel-series configuration operating.

Tapco's injector design concept results in a minimum of trapped propellants between the injector valve seat and combustion chamber. The injection system consists of the following:

—The injector plate establishes the spatial configuration of propellant streams. Injection orifices are drilled in the plate at the desired angles and locations, determining the spray pattern. Impingement accuracy is a function of the drilling operation.

—The injector tubes, interposed between the injector valves and the injector head, conduct the propellant from the valves to the plate and present large equivalent length-to-diameter ratios for the injector orifices. In addition, heat conduction to the injector valve package is minimized—reducing the chance of vaporization in the injector assembly.

—The distributors position the entrance of fuel and oxidizer in two different locations. In the ultimate Tapco design, the location of the distributors will be optimized to accommodate injector valve packages with a minimum of manifolding volume.

The injector has a self-purging action to eliminate postfiring of propellant dribble after shutdown.

Tapco experts note the choice of propellant injector valve and the design of the injector itself have the strongest influence on performance of a hypergolic, bipropellant rocket.

Company spokesmen claim the Tapco design satisfies the three main requirements for optimum combustion performance in the chamber:

—Nearly perfect mass distribution across the combustion chamber cross-section as close to the injector as possible;

—Uniform mixture ratio distribution;

—Correct droplet size to permit hypergolic mixing to proceed without excessive vaporization of oxidizer or fuel out of the reaction zone.

Twelve impinging pairs are used which have experimentally produced combustion efficiencies of 96 to 98% theoretical characteristic velocity.

The thrust chamber will be spherical to gain thermal advantage of a spherical conduction path. The external rocket wall temperature is maintained below 250°F during and after firing through a combination of factors including ablation, insulation, heat sink and radiation cooling.

Tapco's West Coast lab at Inglewood, Calif., conducted the first engineering evaluation test on the S-IVB attitude control rocket last March. All objectives were met. ■

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Star-Pattern Recognition Device Urged

Astropower sees self-adaptive system as step en route to Multi-Function Sensor for spotting landing sites on Moon and planets; sophisticated logic provides new versatility

NEWPORT BEACH, CALIF.—A self-adaptive star-pattern recognition device for space navigation will be proposed to NASA this month by Astropower, Inc. This could be a first step toward development of a Multi-Function Sensor (MFS) capable of automatically selecting safe lunar or planetary landing sites and guiding unmanned roving surface vehicles.

Its designers concede that the device, analogous in operation to a brain, demands more sophisticated logic than is required for simple stellar navigation. In advanced versions, however, it offers broad versatility lacking in a minimum stellar-navigation system and has definite advantages over single-star trackers now used in some guidance systems.

Astropower, a Douglas Aircraft Co., Inc., subsidiary, hopes for an 18-month, $130,000 contract to develop the MFS as a celestial navigator and for simulator study of MFS terrain evaluation. To develop prototype parallel logic systems for all proposed MFS functions would bring the cost to a total of $250,000, according to company estimates.

The system reportedly is based on a thoroughly tested "decision filter" which can identify three-dimensional shapes it has been conditioned to recognize. Recognition is unaffected by size, angle or position of the object because a trial-and-error training process conditions the device to recognize a shape's general properties. This capability could be used to select a planetary landing site for an unmanned vehicle because the system can be conditioned to identify general properties of desirable and undesirable sites.

For relatively simple star-pattern recognition problems, 200 majority logic units are sufficient—no generalization is required. More complex tasks of terminal guidance and landing do require generalization and could require as many as 1000 logic units. But the systems are schematically identical. Intended for limited, specific purposes, the MFS differs in many respects from the Perceptron.

Narrowing the problem simplifies the design process, and results in a much smaller and lighter system. A system version limited to star pattern recognition would weigh 2.3 lb. with a volume of about 56 cu. in., and consume 2.1 watts of power.

- **Orientation**—The star-pattern recognition device is simplified by using a Sun sensor to orient one axis of the vehicle. The spacecraft is rolled about this axis so the sensor scans a search ring perpendicular to the axis and equal in width to the viewing angle of the optics. It is not entirely possible to predict what star patterns will be within the search ring. A position error will shift orientation of the Sun-spacecraft axis and the search ring from their planned orientation. Therefore, parallel logic must be capable of identifying patterns in a band much broader than the search ring.

To simplify the logic, the number of star patterns to be identified can be reduced sharply by using only those in a few search stripes perpendicular to the broad band. The stripes are to be separated by about 90 degrees. If the search ring intersects two search stripes and the device successfully identifies star patterns in the intersections, orientation of the search ring plane can be determined. In combination with the Sun-spacecraft line, this completely determines spacecraft attitude.

The navigation system can recognize a pattern even if some pattern elements are missing or the pattern is rotated. It can be conditioned to ignore such comparatively fast-moving light sources as planets which might cross a recognizable pattern and still identify the pattern if enough of its elements are detected.

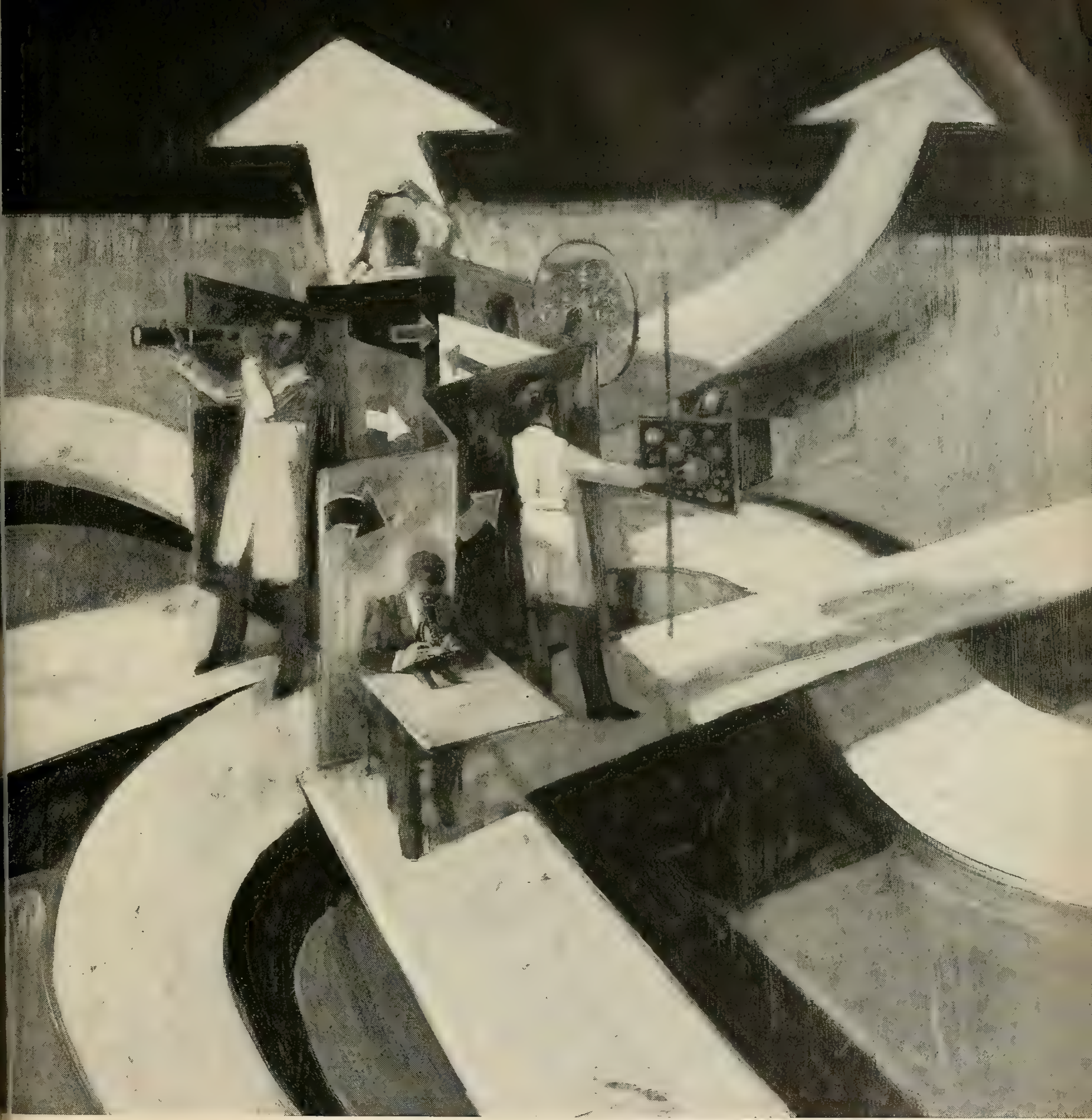
True stars are so distant that their locations on the celestial sphere are virtually the same when viewed from anywhere in the solar system. A single star may be part of more than one pattern, but the navigation system will use only stars of 4.5 magnitude or greater.

A one-cell precision star tracker now under development might be used as part of the optical system retina to refine system accuracy. Without this component, Astropower designers expect a system attitude determination accuracy of ±0.2 degree.

- **Highly reliable**—One advantage of a parallel logic system is the provision of multiple alternative information channels. Failure of any component merely degrades system performance by a small percentage rather than disabling the system, as can happen with sequential logics.

Project engineer S. S. Viglione emphasizes the concept's inherent reliability by proposing to use only low-grade components. In experiments with the Optical Decision Filter with which Astropower investigated parallel majority logic systems, Viglione has deliberately disabled up to 10% of the sensor units and up to 25% of the logic units on a random basis. The filter was still able to classify most shapes it had been conditioned to recognize.

Critics may argue that adequate reliability can be had without such redundancy and with more efficient component utilization. Astropower's re-



THE DISCONTENTED MEN "To be discontented with the divine discontent..." These words of Charles Kingsley describe a frame of mind most often found in the men of research.

For the phrase "divine discontent" could well define the creative impulse that motivates these men. It compels them to search again; to reject things not yet perfect... and to seek, over and over, their refinements.

Today a quantum jump is not a revolutionary feat for research engineers and scientists in the aerospace industry.

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A Close Look at Diamant's Third-Stage Solid Engine

FIRST VIEW of the third stage of the French Diamant rocket. Observer at recent Paris Air Show is shown peering at the charred inner surface of this filament-wound, solid-fueled stage which was recently static-fired successfully. Engine has design thrust of between 5,000 and 11,000 lbs. for 45 sec. Three-stage Diamant is slated for launch of a French satellite in 1965. SEPR and Sud Aviation are reported to be the only competitors on the third stage. A second-generation Diamant, with another third stage, is expected to be in use as a satellite booster in 1967 or 1968. (M/R, May 27, p. 21; M/R, June 17, p. 15).

buttal is that efficiency is not an issue because MFS offers potentialities not present in other systems.

- **Weeding out**—A design process of "natural selection" is used to improve component utilization. Starting point is a basic system of 400 optical sensors and about 1000 logic units. After the system is conditioned to do its job, components which an anlysis shows to be the least effective in determining machine response are eliminated.

A parallel majority logic system is an electronic neutral analog consisting of three component "layers." The "S" layer is a mosaic of sensors and nonlinear amplifiers which produce a signal only when the sensor signal exceeds a selected threshold value. Each sensor element is connected to about seven majority logic units which are analogous to living neutrons and are called the "A" or associative layer.

Connections between S and A units are selected at random, using the Rand table of random numbers to insure a designer's bias is not inserted. Each A unit is then connected to every unit in the "R" or response layer. The R units are essentially switches that control the machine's output, and their number is a function of the number of possible responses.

The random connections between S and A layers would result in random responses except for the self-organization process which "teaches" the machine to identify patterns and forms. The machine is repeatedly presented with a pattern in various orientations and positions. In each presentation, signal strength in A to R connections is increased or decreased until a correct response is obtained—equivalent to reward or punishment in conventional teaching. Some majority logic machines with powers of generalization are organized by "error correction" in which only punishment is used. If, for example, a connection tends to produce a negative response, its conductivity is reduced.

Astropower's "forced learning" approach inhibits connections tending to produce a negative response and reinforces those which tend to produce a positive response. In some parallel logic machines, error correction or forced learning is applied automatically by feed-back loops in the A to R connections. As used by Astropower, forced learning is not an adaptive operation by the machine, but a deliberate process and can be done by digital computer simulation.

The self-organization process is not modified by Astropower. According to Viglione "No attempt is made to incorporate such obviously useful property filters as corner detectors. In this system, property filters must develop in a natural manner out of the selective strengthening of the contributions from various of the randomly wired input connections." The designers do not plan or foresee the visible properties by which the machine identifies things in its visual field.

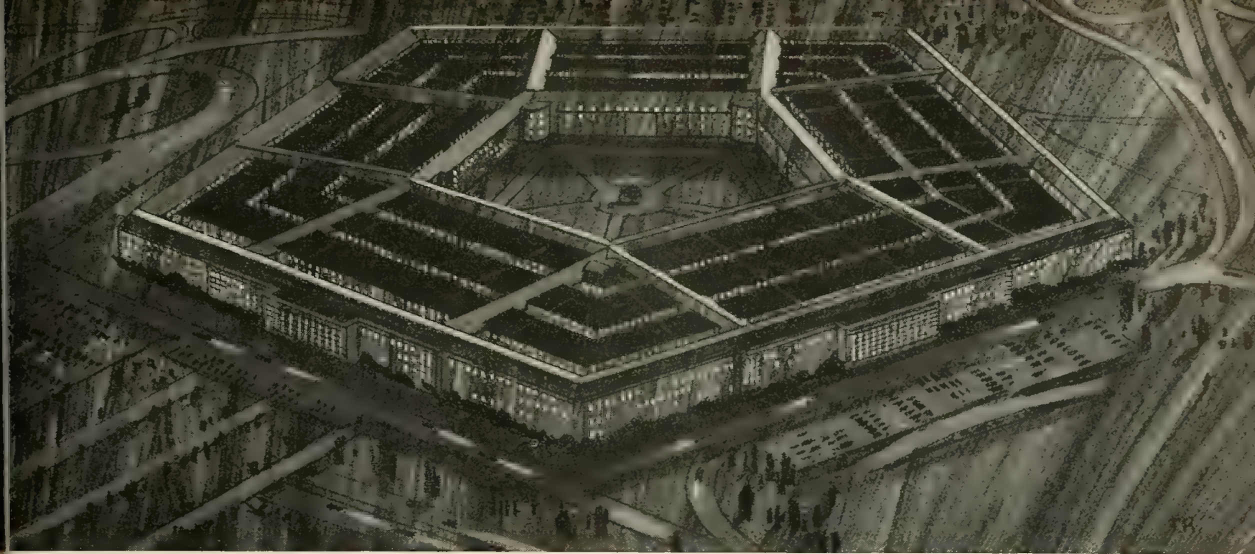
- **Differentiation**—For terrain evaluation, the machine's useful characteristic is an ability to place an observed surface in the correct classification although it has never been "shown" a very similar surface. Correct classification is reached by making a number of yes-or-no decisions.

"If the device is to recognize a short, wide, smooth object, it does so as a number of two-alternative decisions," Viglione says. "Is the object short or tall, wide or narrow, smooth or rough? These binary decisions may be learned independently. Thus, it is possible for the device to place objects into classes of which it has never seen an example. For it may have learned to differentiate between rough and smooth on objects that were neither short nor wide."

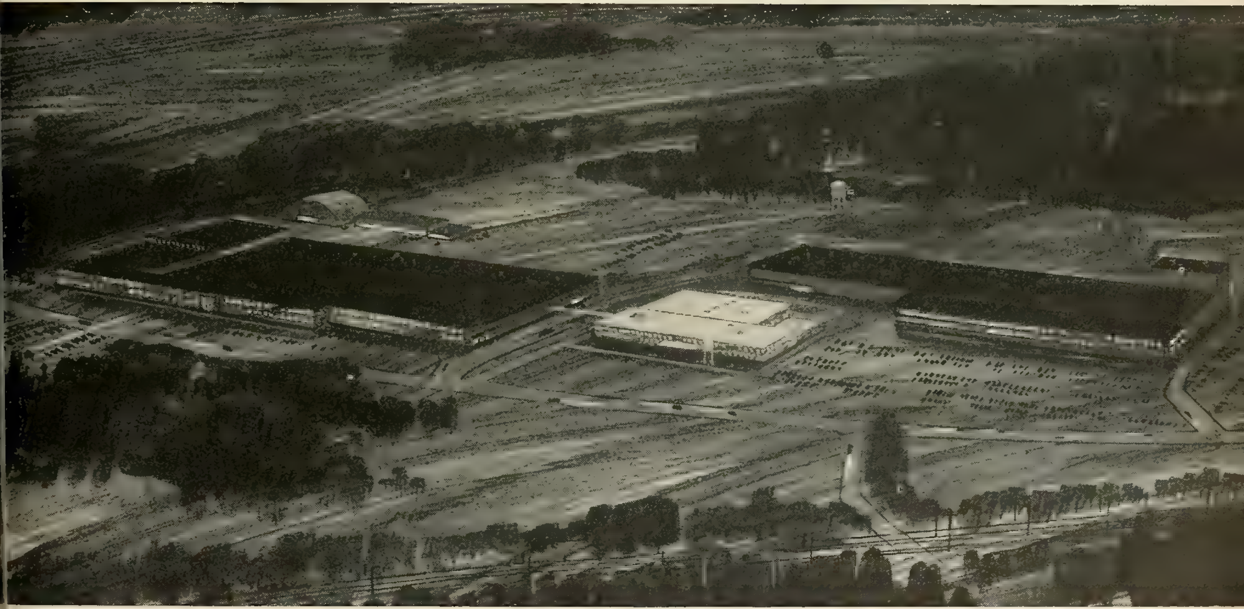
Units in the A layer are called majority logic units—their operation is analogous to voting. The self-organization process changes the number of votes exercised by each unit. Significant combinations of units representing identifiable patterns produce a set of corresponding and distinctive voltage levels at the R layer where they are recognized by the appropriate read-out. In the proposed MFS, a data conversion unit would use this read-out to generate appropriate guidance commands.

Optics of the Astropower MFS consist of a lens system and a three-stage image intensifier tube capable of amplifying the light intensity from viewed objects by a factor of 100,000. The array of photovoltiac cells comprising the mosaic retina is to be deposited directly on the phosphorescent output screen of the intensifier tube's last stage. A layer of amplifiers between the retina and A layer are to provide suitable input strength for the majority logic units. Like the logic units, they are to be modular circuits. Amplifiers, logic units, and response units are to be arranged in toroidal banks around the image intensifier tube to make a compact package.

Development of the optics is regarded as no more than a fairly difficult hardware problem. But it would absorb much of the money in the proposed contract. If the system should undergo further development for the terrain evaluation task, it might prove difficult to provide variable sensitivity to cope with different contrast levels in the visual field. ■



Defense Center



Defense Center

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Cooper's Flight Prompts New Studies

Astronaut's visual powers still debated; orthostatic hypotension problem remains to be corrected

by Heather M. David

THE EXPERIENCES of Maj. Gordon Cooper during the *MA-9* flight have given rise to another spaceflight puzzle as intriguing as that of the "fireflies" seen by the first astronauts.

While the fireflies have been explained as moisture droplets outside the spacecraft, the new phenomenon is less easily explained, and has some far-reaching implications.

During the flight, Cooper claimed to have seen individual houses and chimneys in Tibet and other objects on Earth at a distance thought to be far beyond the resolution of the human eye. His doctors, led by Dr. Charles Berry, say they believe him, and that he really experienced this remarkable visual power.

And new calculations on the resolving power of the human eye in space made by Dr. Hubertus Strughold, Air Force "Father of Space Medicine," tend to bear him out.

Other scientists, however, notably Dr. W. Ross Adey of the Brain Research Institute of the University of California at Los Angeles, attribute the phenomenon to impaired judgment or "disorders of visual perception."

Adey told reporters at a recent meeting that "Cooper's insistence that he could see objects the size of a house from 100 miles up was obviously impossible as any experienced pilot would know."

He added that Cooper's excellent performance during the landing and reentry phase was due to the fact that the human system can "pull itself together" during an emergency.

In addition to the visual resolution puzzle, the astronauts' blood disorder precipitated by re-entry remains unsolved.

• **Blood problem**—NASA doctors are studying ways to prevent the circulation disorder experienced by both of the two most recent U.S. astronauts after they returned to Earth.

Orthostatic hypotension—caused by relaxation of the circulatory system during weightlessness—is a condition from which all astronauts may suffer during and after re-entry, doctors concluded after examining Cooper.

The physicians are working to pin down the extent of the condition and the degree to which differences in individuals affect its onset. For this reason, they are undecided whether one more astronaut should go "unprotected" against it—so that they can study him—or they should begin developing preventive measures immediately. However, all agree that preventive exercises or perhaps special clothing will be necessary as a standard measure in longer-duration flights.

Cooper evidenced the same condition that first showed up when Astronaut Walter M. Schirra stepped out of his capsule after his six-orbit mission last Oct. 3. The effects of the condition were a higher pulse rate, a significant drop in blood pressure and a noticeable reddening of the legs and feet as blood pooled in his lower extremities. As with Schirra, the condition persisted for about seven hours and disappeared to a major degree after the astronaut took his first nap on Earth.

The Air Force's Dr. Duane Graveline said the condition is most likely caused by the effect of weightlessness on the sympathetic nervous system. He said the reduction of stimulation causes a relaxation and subsequent enlargement of the blood vessel system.

Although doctors say Cooper's condition was comparable in degree to Schirra's, Cooper experienced a slight dizziness when he first stood, while Schirra had no other symptoms. This might be due to individual differences, NASA's Dr. Charles A. Berry told MISSILES AND ROCKETS.

Dr. Berry, who is chief of operational medicine for NASA's Manned Spacecraft Center and is responsible for the welfare of the astronauts during their flights, said that he was not surprised at the recurrence of the condition in view of the increased period of the Cooper flight.

Exercises performed by Cooper during the first five orbits were too early in the flight to have prevented the occurrence of the condition.

For these and other reasons, NASA's medical community favored another *Mercury* flight. "There are a lot of things we would like to learn," Dr. Berry told M/R.

Another unresolved question is that of how much sleep astronauts need. Cooper slept and dozed without difficulty and without the aid of drugs, but the doctors say they still do not know how much sleep will be required on future flights—whether it is less than that on Earth. They are also uncertain as to whether all astronauts will be as successful as Cooper in dropping off and being so refreshed by small amounts of sleep.

The only drug used by Cooper during the flight was dexedrine, prescribed by the doctors without his participation in the decision. Berry ordered the drug one hour and 20 minutes before retrofire, because "we felt in view of the situation with the control system that we needed to help him as much as we could." Berry said the doctors felt it was important not to give Cooper another decision to make, and therefore did not ask him if he needed the drug. He emphasized that there was no grogginess or change in Cooper's condition or performance which necessitated his taking the drug.

Cooper said later that he appreciated not having to make the decision and

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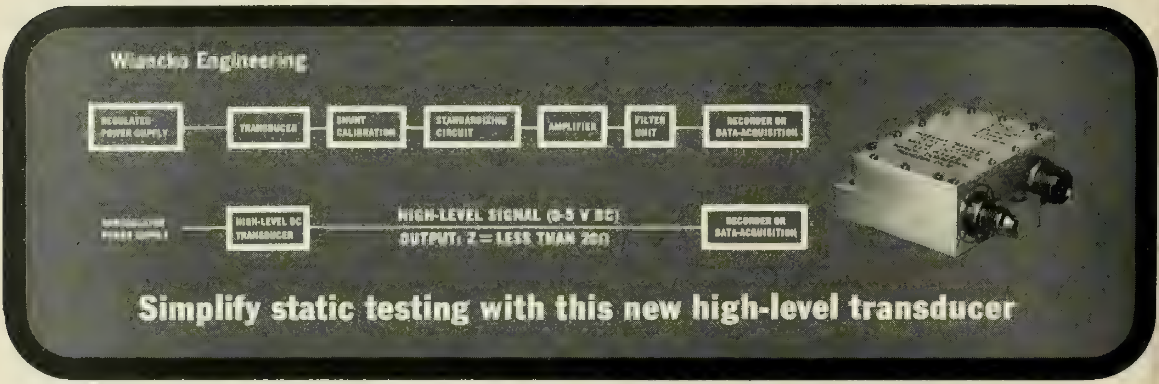
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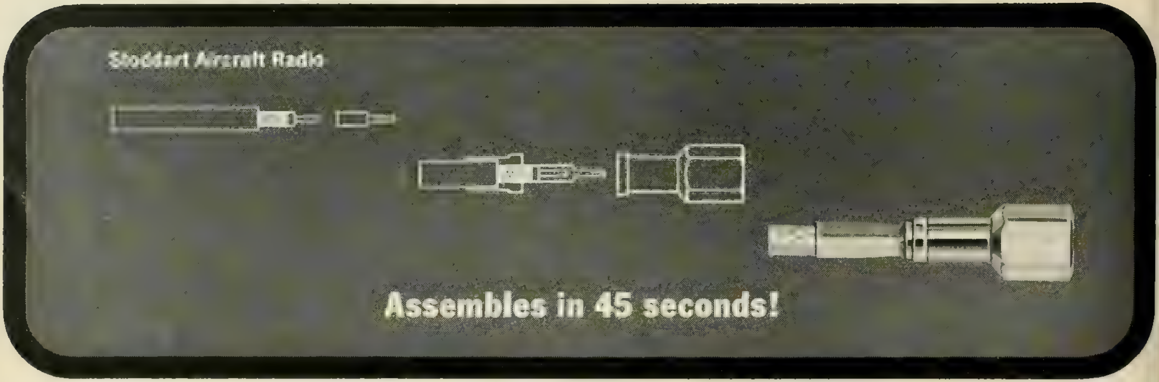

Tamar: three typical contributions to electronics

Tamar Electronic Industries, Inc., is creating advanced electronic devices and systems for both industry and the military. Among the recent achievements of three of the corporation's divisions and subsidiaries are: AMERICAN GYRO — provides Northrop's USAF T-38 supersonic twin-jet trainers with miniature rate gyros which have achieved a reliability in excess of 35,000 hours in flight. WIANCKO ENGINEERING — simplifies static testing with a high-level transducer which drives galvanometer recorders, strip-chart recorders, and automatic data systems directly. STODDART AIRCRAFT RADIO — offers the Tamar-created matched 50-ohm microminiature connector which assembles in 45 seconds and requires no soldering of contacts. For more information about Tamar's wide-range capabilities in electronics, please contact Robert Case, vice-president of marketing.

TAMAR ELECTRONICS INDUSTRIES, INC.
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that he got a marked lift from the drug.

- **Equipment troubles**—Engineers are continuing work on the valve system which regulates cooling of the astronaut suit. Once again, although the system was modified after the Schirra flight, there was difficulty in regulating the valves to get a setting which would stabilize temperature. Although the problem is not severe enough to justify going to another type of cooling system, Berry said, modifications are being fed into the *Gemini* suit systems.

Cooper's intense dehydration was due to malfunctioning of his water supply system and is primarily an engineering problem, Berry said.

Dr. Adey, however, recently pointed out the seriousness of loss of fluid, saying that adequate functioning of brain systems can be affected by changes in body fluid equilibria.

The slight buildup of CO_2 which occurred during the end of the Cooper flight was apparently due to a channeling in the lithium hydroxide tank. NASA spokesmen said that CO_2 will at times cut a path through a bed of LiOH without getting picked up. The tank used at that time was found to be only partially expended.

The level of CO_2 was never serious—never as much as 1% and thus about that of normal atmosphere.

- **Bioinstrumentation**—Cooper's bioinstrumentation worked exceedingly well except for a slight loosening of one electrode on his chest. This gave ground stations only intermittent pneumograph readings, but these were satisfactory and did not cause any concern.

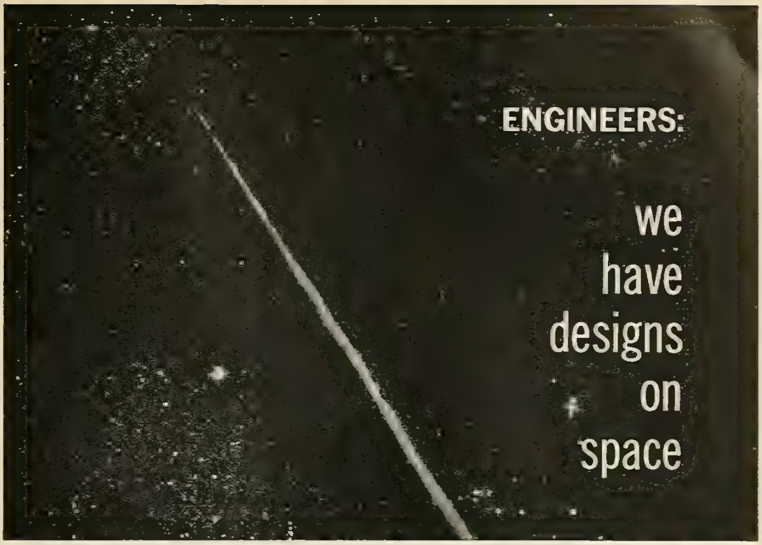
The oral thermometer worked well and the physicians said they found it very helpful to use the same thermometer for suit outlet temperature when it was not in his mouth. Thus they got the temperature increment across the suit.

The blood-pressure cuff designed by the Garrett Corp. worked "perfectly," Dr. Berry said, and showed that the astronaut had remarkably normal readings. Difficulties in an earlier flight were overcome by carefully tailoring the instruments to fit the individual astronaut's arm.

Dr. Berry also said that during this flight he saw no need for monitoring of additional parameters—brain waves by electroencephalogram, for instance.

- **No disorientation**—Cooper's adaption to acceleration changes seemed to be quite good, Dr. Berry said. He felt no sensation of turning over or "going back to Hawaii" at retro-fire, as reported by other astronauts.

There were no psychological or mental reactions or effects of the lengthened period of confinement, Dr. Berry said. ■



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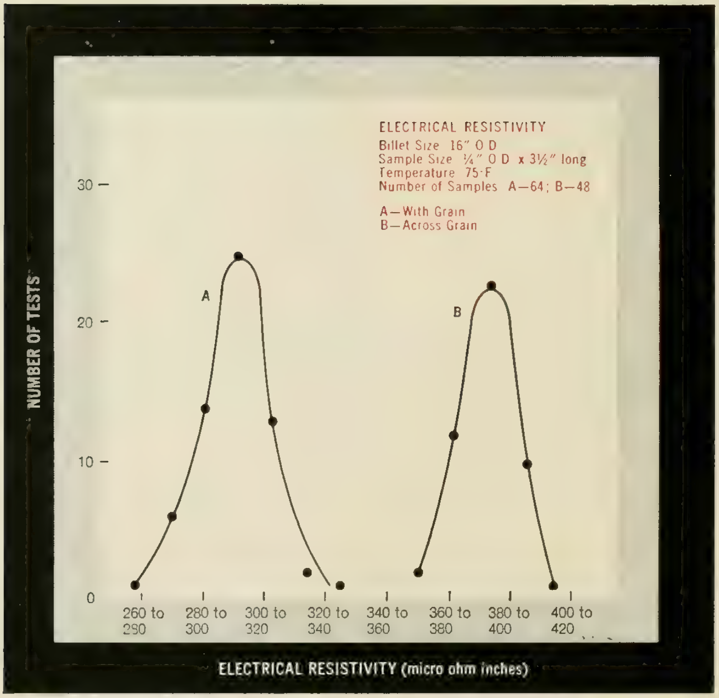

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The Industry Week

New Firms and Divisions

Ford Motor Co.'s Aeronutronic Div. is being transferred to Philco Corp., a wholly-owned subsidiary of Ford. The transfer aims at strengthening Aeronutronic and Philco positions in the space and defense fields. Aeronutronic, which employs some 2,500 at its Newport Beach, Calif., site, will become a division of Philco. . . . *Infrared Industries, Inc., Santa Barbara, Calif., has established a Radiation Electronics division to carry out the company's advanced projects in the field of electro-optics formerly performed by the firm's Instrumentation Div.* . . . Perkin-Elmer Corp., Norwalk, Conn., has incorporated the complete facilities of a subsidiary, Solid State Materials Corp., formerly at East Natick, Mass., into those of the recently constructed $3-million Electro-Optical Div. plant at Wilton, Conn. The move consolidates company capabilities for research, development and production of advanced chrystal materials for laser and other precision optical maser components. . . . *Crane Carrier Industries, Inc., Tulsa, Okla., has formed a new Aero-Space Div. to improve CCI's position in the military and missile/space markets. The new division will occupy a new 120,000-sq-ft building in the Dallas-Ft. Worth industrial area.*

Industry Facilities

Westinghouse Electric Corp.'s Baltimore Electronics Div. soon will have a 3100-ft laser test tunnel as part of its new laser R&D laboratory operation. Walls of the 10x10-ft tunnel will be one-ft-thick poured concrete to afford maximum safety outside the facility. At one end of the tunnel will be the laser laboratory; at the other, a 20x20-ft target building. . . . *Aeroflex Laboratories, Inc., Long Island City, N.Y., manufacturer of aerial cameras and inertial vertical reference systems, is moving to new executive offices and manufacturing facilities in Plainview, N.Y. New facilities contain 55,000 sq. ft. of floor space, including a 2,500-sq-ft instrument and gyro manufacturing and assembly area and a class 4 clean room.* . . . Parker-Hannifin Corp., Cleveland, has released the architect's sketch of its new aerospace components manufacturing facilities at Huntsville, Ala. The new plant will occupy an 18-acre site. . . . *American Metal Climax, Inc., New York City, plans a new $2.5-million research facility for Climax Molybdenum Co. of Michigan at Ann Arbor. Scheduled completion is the latter part of 1964.* . . . Air Reduction Co., Inc., New York City, plans to build a $9-million, 345-ton-per-day air separation plant in Alton, Ill. A portion of the nitrogen produced there is to be used by McDonnell Aircraft Corp. in St. Louis in its new space Simulator Installation.

Representatives Named

The Engineering Supply Co., Houston, has been appointed to distribute Texas Instruments' full line of semiconductors, resistors and capacitors. . . . *Space Engineering Sales, Inc., Huntsville, Ala., has been named sales representative for Tenney Engineering, Inc., Union, N.J., in seven southeastern states. SES will handle Tenney environmental and aerospace products in Alabama, Florida, Georgia, Mississippi, North and South Carolina and Tennessee.* . . . Scientific Instrument Co., Denver, has been named Rocky Mountain Territory representative for Harrel, Inc., Norwalk, Conn. HI manufactures precision temperature controllers and indicators, gyro wheel supplies, and low level d-c amplifiers.

International

Cubic Corp., San Diego, Calif., has concluded arrangements for foreign representation by Racal Ltd., Berkshire, England, and Trans World Trade, Inc., Los Angeles. Cubic's industrial product line includes a family of digital instruments and ground support test equipment and has recently been expanded to include accelerometers, with associate ancillary equipment and a line of taper handling equipment. . . . *The Clary Corp., Los Angeles, is expanding sales and service of its Computer Div. into European markets. The English firm of Digital Measurements Ltd. will represent the Clary DE-60 "Little Giant" electronic computer and arithmetic center in the UK and Sweden.* . . . New England Laminates Co., Inc., Stamford, Conn., has appointed the French Firm, COMERSO, to represent its printed circuitry laminates for sale in the Common Market. NELCO's laminates are used in the U.S. in the electronics and missile/space industries.

Potpourri

Aerospace industry earning as a whole fell materially during the first quarter of calendar year '63, according to Standard and Poor's latest analysis of the industry. The report sees aggregate industry profits for the year as possibly falling below 1962 levels as a result of the poor first quarter. Sales in 1963 are likely to increase about 5%, a smaller gain than last year. Earnings are expected to be hampered by more burdensome non-operating charges. By contrast, the report says many major firms will hit record earnings, or a substantial improvement in final net, this year. . . . *According to a survey just released by the Engineering Manpower Commission of Engineers Joint Council, the average engineering professor's yearly salary is $12,365, but he can expect to earn an additional $3,677 from other professional activities such as consulting or writing. This represents an 11.6% increase over the period 1960-62. Department Heads, it was discovered, earn higher basic salaries, but their total income ($15,864) is lower, presumably because of substantially lower outside earnings. Engineering deans were at the top of salary scale at an average $18,255. Associate professors earned an average total income of $11,838; assistant professors, $9,573; and instructors, $7,055.*

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contracts and procurements

AWARDS

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$4,000,000—**Gilfillan Corp.,** Los Angeles, for interim funding on work involving electronic countermeasures systems.

$2,016,000—**Aerojet-General Corp.,** El Monte, Calif., for studies in advanced liquid-propellant rocket engine design. Work to be performed in Sacramento.

$1,900,000—**Hughes Aircraft Co.,** Culver City, Calif., for long lead-time items for GAR-2B *Falcon* missiles.

$1,300,000—**Marquardt Corp.,** Van Nuys, Calif., for work on a classified project.

$1,000,000—**Geotechnical Corp.,** Garland, Tex., for work on a classified project.

$400,000—**General Electric Co., Nuclear Materials and Propulsion Div.,** Cincinnati, for research toward design criteria for a fast-energy spectrum nuclear rocket engine.

$312,500—**Benrus Watch Co.,** Waterbury, Conn., for a guided missile launcher assembly.

$303,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for a study of internal environment of solid-rocket nozzles.

$291,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for applied research to develop a unique solid propellant grain.

$242,000—**Bell Aerosystems Co.,** Buffalo, N.Y., for pneumatic components for rocket propulsion systems.

$223,000—**Acoustica Associates, Inc.,** Los Angeles, for research on propellant utilization and control for spacecraft.

$210,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Great Neck, N.Y., for two radomes.

$200,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for development of light metal hydride hybrid propellant system.

$173,400—**Rocket Research Corp.,** Seattle, for development of microrocket engine for testing high-energy propellants and new technology.

$150,000—**Eagle-Picher Co.,** Joplin, Mo., for silver zinc batteries for the GAR missile family.

$30,100—**Bath Iron Works Corp.,** Bath, Me., for working plans for construction of three guided missile escort vessels.

ARMY

$10,000,000—**Philco Corp.,** Philadelphia, for electronics equipment.

$4,300,000—**Sperry Rand Corp., Sperry Utah Co.,** Salt Lake City, Utah, for *Sergeant* missile repair parts, launcher equipment, checkout gear, containers and new training equipment (15 contracts).

$2,100,000—**Sylvania Electronics Systems Co.,** for modification on a mobile digital computer. Work to be performed at Needham Heights, Mass., and Fort Huachuca, Ariz.

$2,100,000—**Martin-Marietta Corp.,** Orlando, Fla., for *Pershing* missile system engineering services.

$1,810,938—**R. E. Clarson, Inc.,** St. Petersburg, Fla., for construction of twin launch umbilical tower foundations in connection with NASA's *Saturn V* moon exploration complex.

$1,103,403—**General Dynamics Corp.,** Pomona, Calif., Div., for continued research and development on the *Mauler* weapon system.

$825,000—**Aircraft Armaments, Inc.,** Cockeysville, Md., for *Sergeant* missile training devices.

$300,000—**Franklin Institute Laboratories,** Philadelphia, for analysis of the communication experiment data received from the NASA *Syncom* satellite.

$286,800—**General Dynamics Corp.,** Pomona, Calif., Div., for *Redeye* missile facilities.

$160,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for repair parts and overrun production of *Nike* missile system components.

$100,000—**ITT Federal Laboratories,** Nutley, N.J., for services and materials for two transportable satellite communication terminals.

$39,500—**AA Industries, Inc.,** Detroit, for production of precision angular indexing table for the White Sands Missile Range, N.M.

$33,000—**Hughes Research Laboratories,** Malibu, Calif., for nonnuclear antimissile warheads.

NAVY

$2,100,000—**Minneapolis-Honeywell Regulator Co., Ordnance Div.,** West Covina, Calif., for a sonar room tactical team trainer for the FBM facility at Charleston, S.C.

$1,800,000—**Aeronca Manufacturing Corp.,** Middletown, Ohio, for design, fabrication and erection of a complete tracking system at Waldorf, Md.

$1,200,000—**Northrop Corp., Nortronics Div.,** Norwood, Mass., for *Polaris* guidance system gyroscopes.

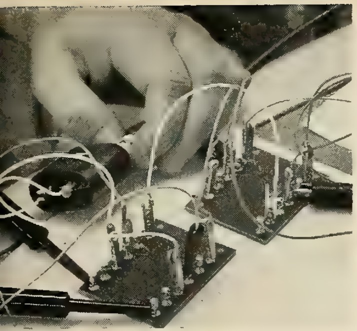
$469,000—**Northern Ordnance, Inc.,** Minneapolis for *Tartar* guided missile launching system.

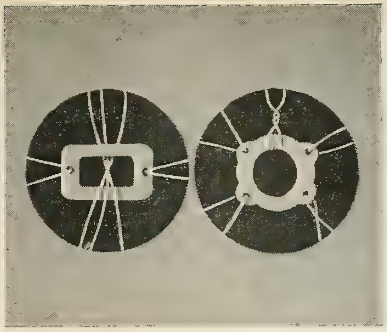
$233,307—**Vitro Corp. of America, Vitro Laboratories Div.,** Silver Spring, Md., for research and development on missile weapon systems

NASA

$35,844,550—**General Motors Corp., AC Spar Plug Div.,** Wakefield, Mass., for fabricatio assembly and test of the navigation an guidance system for the *Apollo* Comman Module.

$15,000,000—**Raytheon Co.,** Lexington, Mass., fo fabrication and assembly of the onboard digita computer for the navigation and guidance sys tem of the *Apollo* Command Module.





espite the tremendous speed and raven- s appetite of today's most advanced mputers, scientists at Lockheed Mis- es & Space Company's Computer Re- arch Laboratories feel that there is room a great deal of improvement. They have dicated themselves to the discovery and velopment of ways to increase the speed d reliability of computers while simpli- ng their operation.

Though today's computer circuits are pable of operating at speeds measured tens of nanoseconds, the useful com- tation rate is far slower. One of the adblocks hindering speed is the need the computer to wait for the carryovers m one column of figures to catch up th the main calculation. A possible answer to this problem is modular arithmetic, which avoids carryover. Based on the ancient Chinese Remainder Theorem, this concept is being re-examined at Lockheed for potential computer applications.

Lockheed's Computer Research Laboratories are studying a very broad group of related computer research areas, and the company can boast that an unusual number of its specialists are at the very forefront of their specific fields.

Among the major areas of research being undertaken at this time are basic physical phenomena, such as phonons; quantum mechanics; switching theory; residue arithmetic (number system research); threshold logic and pattern recognition and logic design techniques.

LOOK AT LOCKHEED...AS A CAREER Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile, the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-48C, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

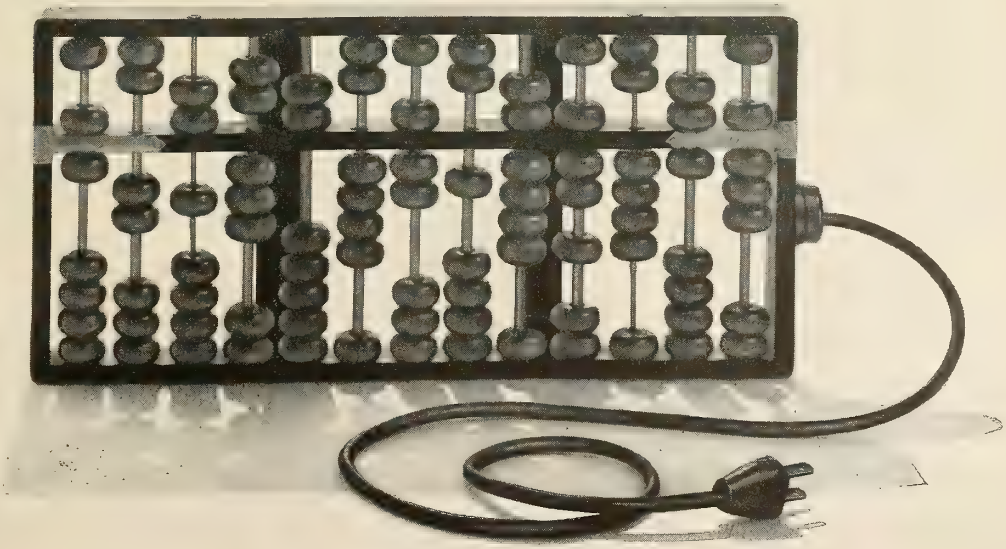
SCIENTISTS & ENGINEERS: In addition to positions relating to computer research, such as logical design specialists and mathematicians, other important openings exist for specialists in: Trajectory analysis • Inertial guidance • Electromagnetics • Orbit thermodynamics • Gas dynamics • Chemical & nuclear propulsion • Systems engineering • Electronic engineering • Communications & optics research

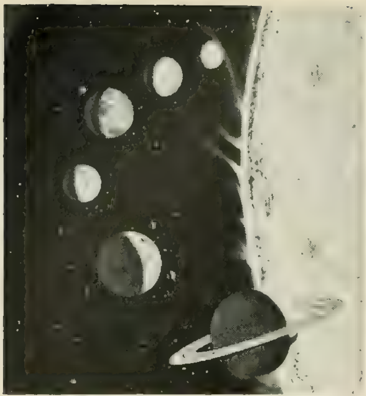
LOCKHEED
MISSILES & SPACE COMPANY
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Sunnyvale, Palo Alto, Van Nuys, Santa Cruz, Santa Maria, California • Cape Canaveral, Florida • Huntsville, Alabama • Hawaii

OOK AT LOCKHEED IN DIGITAL TECHNIQUES:

asic research toward simpler, faster, more reliable computers





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SPACE AND INFORMATION SYSTEMS DIVISION
North American Aviation

$3,200,000—**Aerojet-General Corp.**, Azusa, Calif., for further work on the SNAP-8 nuclear auxiliary power program.

$473,000—**Hughes Aircraft Co., Research Div.**, Malibu, Calif., for research, development, technology and engineering for 3MK ion rocket engine.

$175,000—**Spectrolab, Inc.**, North Hollywood, Calif., for design, fabrication and installation of a solar simulator system.

$160,000—**University of Michigan**, Ann Arbor, for research and development program on neutral partical pressure, temperature and density connected with Pitot static probe.

$116,300—**General Technology Corp.**, Torrance, Calif., for further work on a magnetic induction plasma engine development program.

$107,600—**Ralph M. Parsons Co.**, Pasadena, Calif., for spaceborne tape recorder equipment.

$76,000—**Westinghouse Electric Corp.**, Pittsburgh, for a design study of nuclear reactors for space power in the 1-5 MW range.

$50,000—**Bemco, Inc.**, Pacoima, Calif., for a high-altitude environmental test chamber.

LFE Electronics, Inc., Boston, for an investigation of optimum design of a radar system for accurate measurement of the altitude and velocity of an orbiting space vehicle (undisclosed amount).

INDUSTRY

$1,500,000—**General Precision, Inc.**, Glendale, from **Minneapolis-Honeywell Regulator Co.**, for production of additional guidance computers for the *Centaur* spacecraft.

$630,000—**General Precision, Inc., Information Systems Group, Librascope Div.**, Sunnyvale, Calif., from **Westinghouse Electric Corp.**, for production of exploding bridgewire firing systems for the *Polaris*-launching submarines.

$500,000—**Royal Industries, Inc.**, Pasadena, Calif., from **Allis-Chalmers' Atomic Energy Div.**, for provision of a set of major components for the nuclear reactor being built near La Crosse, Wis.

$500,000—**Telecomputing Corp., Whittaker Controls and Guidance Div.**, Los Angeles, from **The Boeing Co.**, for development, design, test and production of the liquid oxygen tank vent and relief valve for the S-IC booster, first stage of the *Saturn V* vehicle which will carry the *Apollo* spacecraft aloft.

$86,000—**General Electric Co., Technical Products Operation**, Syracuse, N.Y., from **The Boeing Co.**, for a large-screen television projector for use in a spaceflight simulator.

B. F. Goodrich Aerospace and Defense Products, Akron, Ohio, from the **Thiokol Chemical Corp.**, for fabrication of large segmented fiberglass rocket motor cases (undisclosed amount).

Gulton Industries, Metuchen, N.J., from **United Technology Development Center**, for the data acquisition and processing system for environmental meausurements of the *Titan* III-C 120-in-dia. solid-propellant rocket motors (undisclosed amount).

Telecomputing Corp., Whittaker Controls and Guidance Div., Hollywood, Calif., from **Rocket Research Corp.**, for development of propellant valves for a new microrocket (undisclosed amount).

REQUEST FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Flight Research Center
P. O. Box 273
Edwards Air Force Base, Calif.

A request for proposal identified as PR-788 is being solicited from General Electric Co., for the inventory management of J-79-GE-11A turbojet engines spare parts and aerospace ground equipment. Request for proposals are not available and no other proposals will be considered. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with General Electric Co., Edwards, Calif.

Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Lockheed Missiles and Space Co., Box 504, Sunnyvale, Calif., for provision of PX-1 pyrotechnics samples for service life evaluation tests and conduction of required tests. This procurement is being made from the source which has the responsibility of designing and developing the development program and as such must be under their control and coordination. This notice made for information only. P. R. No. SP 1324-63-4. BuWeps Synopsis No. 495-63.

National Aeronautics and Space Administration
General Research Procurement Office
Houston 1, Tex.
Phone: WA 8-2811

Study on the thermal performance degradation of ablators due to penetrations. Evidence of possession of an adequate plasma-arc facility or procurement of a firm lease agreement must be included in the proposal to receive consideration. RFP MSC-63-681P. RDP due date 7-12-63.

National Aeronautics and Space Administration
Contracting Officer
Langley Station
Hampton, Va.

S/M necessary for fabrication and delivery F.O.B. Hampton, Va., hatch doors in accordance with NASA Spec. L-3609. Bidders must submit evidence that they have satisfactorily manufactured similar items—2 each. IFB L-3609. Bid opening 7-2-63. Copies of IFB will be furnished to the extent available on a first-received, first-served basis.

Air Force Special Weapons Center (AFSWC)
Procurement Directorate, Attn: SWKB
Kirtland Air Force Base, N.M.

Increase in contract scope of work to provide for one RVU-4/E dummy re-entry vehicle on Contract AF29(601)-5016 with Graco Engineering and Manufacturing Co., Gardena, Calif. This notice is for information purposes only. RFP not available and RFP due date not furnished.

Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Lockheed Missiles and Space Co., Box 504, Sunnyvale, Calif., to furnish missile component shipping containers, P/N 2337817. Procurement is being made from the source currently designing the containers and which has responsibility for compatibility of containers with components. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting opportunities should contact the above firm direct, referencing P.R. No. Sp 1322-63-7. BuWeps Synopsis No. 496-63.

U. S. Army Missile Command
Procurement and Production
Special Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXDA

Selected source procurement for contract with Ford Instrument Co. Div. of Sperry Rand Corp. for the design, study, fabrication, test and checkout of a directional control gyro. This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.

Selected source procurement for contract with Litton Systems, Inc., for the design, study, fabrication, test and checkout of a digital accelerometer. This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.

U. S. Navy Dept.
Bureau of Ships
Washington 25, D.C.

Furnish drawing documentation program pertaining to the Mark II Mod. O and Mark II Mod. 2 SINS equipments. RFP SP24-1223(S). This equipment was especially designed and built by North American Aviation, Inc. Request for proposal has been issued to the following firm: North American Aviation, Inc., Autonetics Div., 9150 E. Imperial Highway, Downey, Calif.

Contracting Officer
Naval Weapons Laboratory
Dahlgren, Va.

Furnishing of the necessary services and material to conduct a research and development study program directed toward an operational analysis of a direct-readout weather satellite system. A contract is in process of being awarded to Radio Corp. of America, Astro-Electronics Div., therefore, other proposals cannot be considered for this procurement—1 item. Deliveries to the U.S. Naval Weapons Laboratory, Dahlgren, Va.

Special Contracts Branch
Procurement Div.
U. S. Army Missile Command
Redstone Arsenal, Ala.

Selected source procurement with Chance-Vought Corp. of Dallas, Tex., for a period of six months, feasibility study on homing optical guidance seeker. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor.

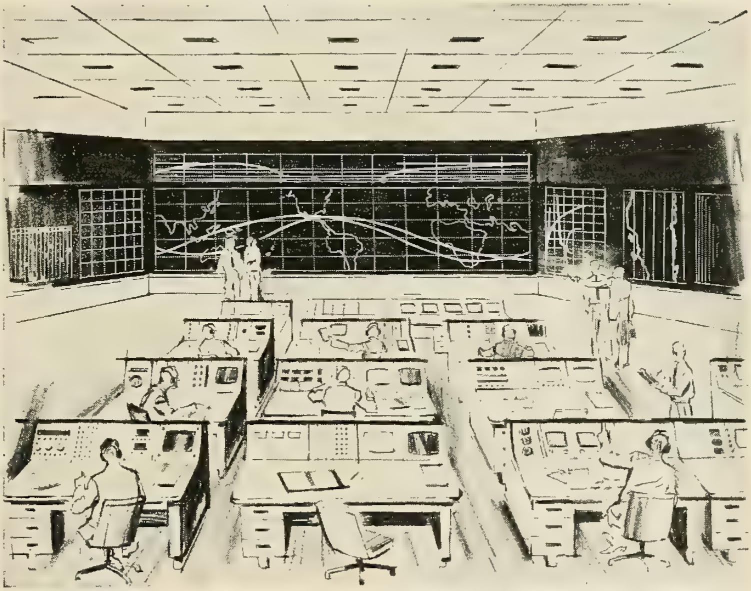
National Aeronautics and Space Administration
Wallops Station
Wallops Island, Va.

Service and materials necessary to rehabilitate two MPS-19/MSQ-1A radar systems and two OA-626/MSQ-1A computer systems as a first step under a two-step formal advertised procurement. Job—RFP P-717. RFP due date 7-9-63.

Hawk Project
Manager's Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Factory test equipment for the Nato-*Hawk* Program—9 items. Delivery complete in October 1963. Duplication of initial investment, special tooling and facilities, plus the nonavailability of drawings and specs adequate to support competitive bidding precludes award to other than the prime contractor, Raytheon Co., Willow St., Waltham, Mass. All inquiries relative to subcontracting opportunities should be referred to the Raytheon Co.

PHILCO TO DESIGN APOLLO CONTROL CENTER



OUTSTANDING OPPORTUNITIES AT:

PHILCO IN HOUSTON
- System Management
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- Installation & Checkout
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PHILCO IN PALO ALTO
Design and Development of:
- Simulation Equipment
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- Consoles

From concept through hardware, designing the Gemini rendezvous and the Apollo communications and control center is one of the vital and exciting new challenges at Philco. Selected career positions are now available in this and other advanced programs, as the Ford/Philco commitment to space programs increases.

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3870 Fabian Way, Palo Alto, Calif.
Attn.: Mr. Patrick Manning
1200 Main St., Houston 2, Texas
Attn.: Mr. T. L. Arnett

As systems integration contractor for the USAF TITAN III program, MARTIN DENVER has a current need for individuals with

INVENTIVE

talents and a desire for challenging career assignments in the following—and related—areas of science and engineering:

- EXPERIMENTAL THERMO-DYNAMICS
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Martin's present expansion offers you exceptional opportunities for professional growth and advanced education, plus ideal working environment and family living conditions.

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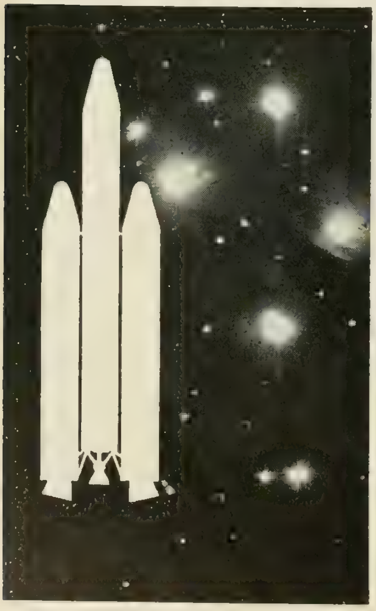
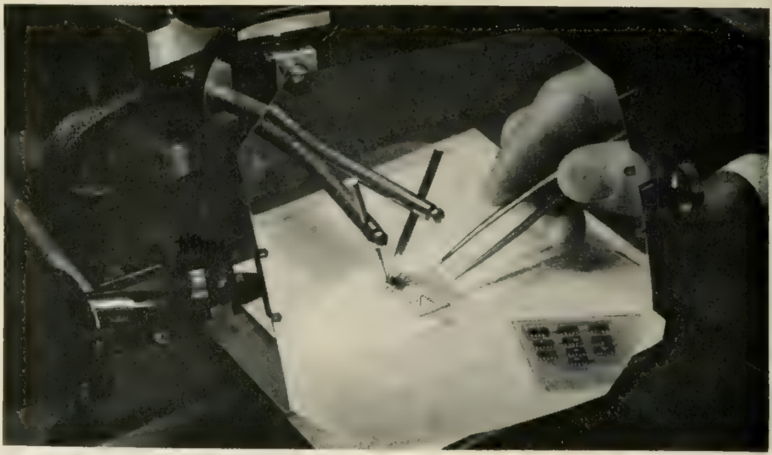




New Product of the Week:
Microminiature Welder

The Boeing Co. has developed a device that can weld wires half the thickness of a human hair to surfaces only a few thousandths of an inch thick.

The machine controls duration accurately from 1/1000 to 1/16 of a second. Electrode pressure can be varied from less than an ounce to 24 lbs. Boeing has welded or soldered components with wires and ribbons as small as 1/2000th of an inch thick. Heat control is accurate enough to join metal parts of solar cells, which are composed mainly of glass-like silicon.

By doing away with flux requirements for certain soldering operations, the machine takes a long step toward eliminating soldered-joint contamination caused by the flux.

Currently the welding device is employed in fabricating components used in research and development, manufacturing experimentation and product research.

Circle No. 225 on Subscriber Service Card

Environmental Test Chamber

General Vacuum Corp. is marketing a line of 5-ft.-dia. standard environmental test chambers in lengths of 4, 5 or 6 ft. with interchangeable doors and shrouds for 10^{-8} torr performance, and achieving 1×10^{-7} torr in less than three hours.

The chamber is pumped by a 20-in., 18,000 liter per second pump and uses a high conductance liquid-nitrogen trap with 100% anti-creep characteristics. By the use of interchangeable shrouds, controlled temperature from —300°F to 400°F can be obtained.

Circle No. 226 on Subscriber Service Card

Nitrogen Level Controller

A liquid-nitrogen-level control system for use with self-pressurized dewars and incorporating an automatic-supply dewar switching system has been developed by Cryogenics, Inc.

The Model 100LMT-2 includes two dewar M-T alarm sensors as integral electromechanical attachments to the liquid nitrogen solenoid valves. The system senses when the first self-pressurized dewar is empty. It then automatically switches the supply control function to the second supply dewar. When the dewar switching control is activated, a red light on the front panel is energized alerting the operator to the fact that the first dewar is empty and should be replenished.

Circle No. 227 on Subscriber Service Card

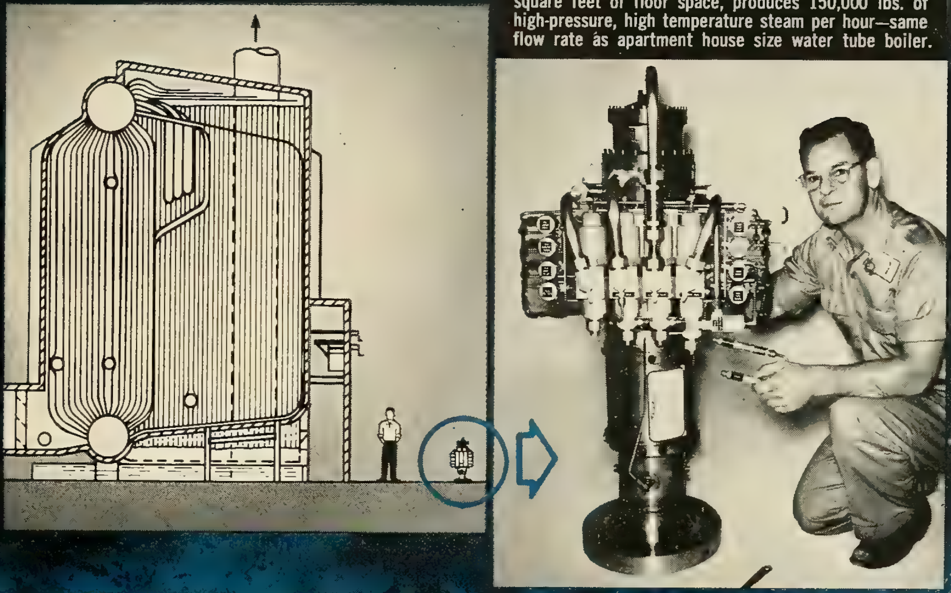
Multifrequency Dipole Feed

Andrew Corp. has developed a multifrequency dipole feed that operate in five bands between 52 and 1500 mc Throughout this range, the phase cente position of the feed remains relativel constant assuring proper illumination o the larger reflector. VSWR in each o the five inputs is less than 2.1.

The unit provides multifrequenc wide band coverage for the study of th ionosphere, planets and of the geomagnetic forces of the Earth.

Circle No. 228 on Subscriber Service Card

Space Environment—IN AN INSTANT



Hyprox (hydrogen peroxide) steam generator occupies six square feet of floor space, produces 150,000 lbs. of high-pressure, high temperature steam per hour—same flow rate as apartment house size water tube boiler.

Hyprox at Reaction Motors—75,000 lbs. per hour steam flow rate

Hyprox at JPL-EAFB—300,000 lbs. per hour steam flow rate

Hyprox at Elkton—300,000 lbs. per hour steam flow rate

THIOKOL DESIGNED ALTITUDE FACILITIES, WITH COMPACT HYPROX STEAM GENERATORS, MEET COMPLETE RANGE OF SPACE SIMULATION REQUIREMENTS.

For testing its own space engines and components, Thiokol developed the Hyprox Steam Generator. Midget in size, giant in performance, Hyprox provides rated high pressure steam flow (4,000 to 45-million pounds per hour depending on model) in only fifteen seconds. Steam quality or degree of superheat can be varied automatically.

At present, Thiokol-designed and installed altitude facilities are demonstrating high reliability and capacity at JPL-Edwards Test Station and at Thiokol's Elkton and Reaction Motors Divisions. THIOKOL CAN PROVIDE COMPLETE OPERATIONAL ALTITUDE FACILITIES AT EXTREMELY LOW COST, IN LESS THAN FIVE MONTHS.

INQUIRIES SHOULD BE FORWARDED TO
SHAWNEE INDUSTRIES, INC.
A SUBSIDIARY OF
THIOKOL CHEMICAL CORPORATION,
P.O. BOX 549, SHAWNEE, OKLAHOMA

Thiokol CHEMICAL CORPORATION

Circle No. 25 on Subscriber Service Card

Receiver Calibrator

Semi-automatic, error-free calibration and troubleshooting of microwave receivers can be done with a converter test set developed by Loral Electronics Corp.

Model 150792 enables measurements and tests of sensitivity, selectivity and frequency accuracy in the maintenance of both manual and servo-controlled superheterodyne frequency converters.

The converter test set is housed in a self-contained dual cabinet console that includes oscilloscopes, frequency counters, detectors and market generators. In each band, eleven preprogrammed frequencies are available on push-button control for tuning the generator and converter.

Circle No. 229 on Subscriber Service Card

High-Speed Printer

Two systems to provide present computer users flexible and economical off-line and on-line high-speed printing facilities have been developed by Addressograph-Multigraph Corp.

Both systems employ production proven 1,000-line-per-minute print stations manufactured by the Anelex Corp.

In addition to its prime use as a high-speed off-line editing printer, the AM Model 960 system is also capable of performing a number of other data-processing functions. A 4,000-character magnetic core memory stores data to be processed and programs to be executed. Arithmetic and comparison logic is provided. Input may be magnetic tape, punched cards, or paper tape, and output can be printed copy, magnetic tape and punched paper tape.

Circle No. 230 on Subscriber Service Card

Impulse/Sequencing Relay

An impulse/sequencing, single-coil relay series allowing a choice of two or four sets of Form C (SPDT) contacts has been developed by Potter & Brumfield Div. of American Machine & Foundry Co.

Particularly flexible for applications where automatic sequencing by single coil latching is indicated, the relay is available in two standard designs. The GM is furnished in a ratchet-and-pawl design where a two Form C (DPDT) contact arrangement is switched alternately by indirect cam action during drop-out of the armature. Designated as the GML, it is equipped with an additional set of two Form C (DPDT) auxiliary contacts operated directly by the armature.

For specific sequencing, a custom design utilizing the basic GM motor structure can be arranged to include a 12-position unidirectional stepping switch with printed circuit strips to switch currents up to 250 milliwatts.

Circle No. 231 on Subscriber Service Card

Air Core Dewar Assemblies

A dewar that allows the magnetic field of a superconducting magnet to be concentrated in a room-temperature air space instead of in a bath of liquid helium is available from the Westinghouse cryogenic systems department. The unit is a nitrogen-shielded, stainless steel vessel consisting of six concentric cylinders. The inner cylinder is open at both ends to provide a one-inch-dia. access to the superconducting solenoid's magnetic field.

Both the helium and nitrogen chambers are vented to the atmosphere. The vacuum chambers are interconnected and have a combination safety and pumpdown valve. The device is designed to withstand inner-chamber mechanical forces that may develop if the superconducting magnet is driven to its normal state.

Helium capacity is four liters; losses are as low as ⅛ liter per hour. Nitrogen capacity is between eight and nine liters.

Circle No. 232 on Subscriber Service Card

Problem:

TAME THE BIG FLAME!

The assignment: Build and test-fire America's first one million pound thrust, 156" diameter solid propellant rocket engines, with special emphasis on the use of jet tabs for thrust vectoring. Motor number one to be tested within eight months! To guide and control this Niagara of fire is the core of the vital defense project recently awarded Lockheed Propulsion Company by the Space Systems Division of the Air Force.

Roaring out of the exit cone at Mach 3 and a temperature over 3,000 degrees F., the big flame must be tamed and directed; an engineering challenge of the first magnitude.

This crucial program is of more than usual interest to scientists and engineers concerned with growth and development. For it means this young, fast-growing company is now in position to provide even more in the way of ground-floor openings.

SCIENTISTS AND ENGINEERS: We know our best years are ahead of *us*—just as your best years are ahead of *you*. Therefore, we invite you to explore openings in: Operations Analysis; Propulsion Analysis; Visco-elasticity; Design Engineering; Proposal Engineering; Project

LOCKHEED PROPULSIO

VSWR Measuring Kit

Telonic Engineering Corp. is marketing two test kits for VSWR measurement, one covering frequencies from 1 mc to 1 gc, the second covering 1 mc to 2.5 gc.

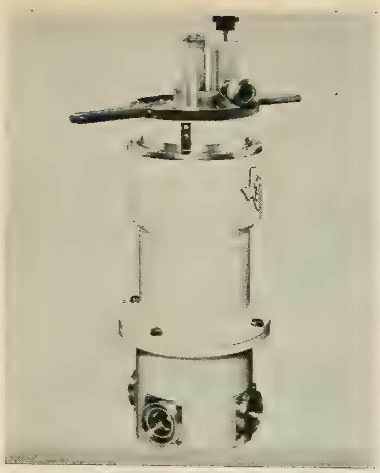
Both kits contain a Telonic-Rho-tector, two standard 50-ohm matching terminations, and two mismatch terminations with valves selected by the purchaser. These three units enable the user to measure VSWR in a wide variety of applications and with a high degree of sensitivity.

The Rho-tector device utilizes a bridge circuit to produce a dc voltage directly proportional to the magnitude of reflection coefficient of the unknown item being tested, vs. the known standard termination with a VSWR of 1:1. Calibration is accomplished by substitution of a standard mismatch for the unknown impedance.

Circle No. 233 on Subscriber Service Card

Multiple Target Bolometer

Using a rotating seal on the nitrogen-less "cryoflask" dewar, the industrial products group of Texas Instruments Inc. has available for infrared studies a multiple-target bolometer system. With a liquid helium charge in the dewar, basic germanium-detector response covers from one micron to 10 millimeter radiation wavelengths with noise equivalent powers of as small as $5x10^{-13}$ watts. The multiple-target operation provides for including various filter setups or detectors with thermal time constants chosen for optimum responses.



Circle No. 234 on Subscriber Service Card

Preamplifier System

A preamplifier system for operation from 0.55 to 10.75 gc is available from Applied Technology, Inc.

Each unit includes an integral solid-state power supply for independent operation. PPM- and PM-type traveling wave tubes are used in the MWA-5.

The system operates under temperature variations ranging from —50° to 50°C, and ±10 line voltage operations.

Versatility of operation is further evidenced in that the system can be operated from three primary power sources: 115/230v, 55 to 420 cps or 24 to 30 v dc.

Circle No. 235 on Subscriber Service Card

Passive Solid State Relay

A miniaturized neutral-to-neutral solid-state relay for signal communications networks has been developed by Ortronix, Inc.

The only power required to drive the unit is that normally provided by the telegraph line. Complete line/ground isolation is provided. Protection against over-voltages or improper connection is inherent in the design of the units.

Model #4503 relay may be used in in-station and out-station telegraph circuits and offers better than optimum performance when used to provide line isolation between the in-station and out-station telegraph loops.

Circle No. 236 on Subscriber Service Card

Engineering; Tactical Weapons Engineering; Propellant Development; Physical or Inorganic Chemistry; Chemical Engineering; Thermodynamics; Aerodynamics; Stress and Stress Analysis; Reliability Engineering.

Write: Professional Employment office, Dept. 5206, P.O. Box 111, Redlands, California. An Equal Opportunity Employer.

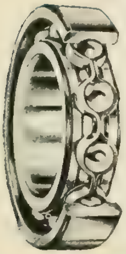
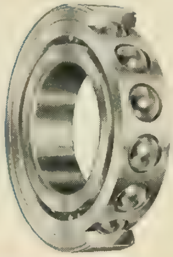
P.S.—A word to the wives (husbands, too). Living is mighty pleasant in Redlands. This smog-free, friendly community, with fine schools and universities, shopping centers, etc. is only an hour and a half drive from Los Angeles; and with quick access to famed Southern California mountain, desert and beach resort areas.

OMPANY **REDLANDS, CALIFORNIA**

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

HOW TO INCREASE PAY-LOAD

A reduction in bearing size—without sacrificing load capacity or functional capability—makes possible a corresponding reduction in the size and weight of adjacent components. The following table illustrates this advantage with patented SBB construction ball bearings.

CONRAD-105	SBB-105
BALL CONTENT	
10 1/4 INCH BALLS	14 9/32 INCH BALLS
RETAINER	
TWO-PIECE	ONE-PIECE
CAPACITY	
RATED 700 LBS. 500 R.P.M.	RATED 1100 LBS. 500 R.P.M. 56% more capacity
AVERAGE LIFE	
500 HOURS For above rating	1400 HOURS For above rating 280% Longer life

Missile Quality Ball Bearings

Our exclusive patented SBB construction ball bearings are available in twenty standard series and constructions, as well as special designs, in a range of precision up to ABEC 7. Write for a descriptive catalog or contact your MPB sales engineer.

MPB
INCORPORATED
SPLIT BALLBEARING DIVISION
LEBANON, NEW HAMPSHIRE

Circle No. 26 on Subscriber Service Card

Two-in-One Microsyn

A two-in-one microsyn is available from the Sperry Electro Devices Laboratory. The component does jobs in internal navigation packages usually requiring two, separate, microsyns with no increase in size over standard units.

It is a combination d-c torquer and a-c pickoff suitable for use either with gyroscopes or accelerometers, and has proved itself in actual system operation.

Specifications for pickoff are: input 5 volts at 6.4 kc, output 0.5 volts/degree, linearity 1%, impedance 88 + j235 ohms; and for torquer input 0-5 ma, output 100 dynes-cm/ma, linearity (Range ±5 ma) 1%.

Circle No. 237 on Subscriber Service Card

Scan Converter Storage Tube

The Rauland Corp., a subsidiary of Zenith Radio Corp., has developed an ultrafast Scan Converter Storage Tube that records and stores transient phenomenon with pulse rise times in the range of a nanosecond or less.

The design of the tube permits slow scanning techniques to be used for relay of the transient pulse data over narrow band systems of 100 kc band width or less. The pulse may also be recorded by conventional means (on magnetic tape), be transmitted over inexpensive telemetry links, over communication cables, be displayed on an ordinary television monitor and be photographed using "box camera" exposure time.

Circle No. 238 on Subscriber Service Card

Electronic Thickness Tester

Twin City Testing Corp., has available Permascope, type ES 3 e NB, for accurate measurement of any nonmagnetic coating thickness on a magnetic base.

The electronic unit features a transistorized amplifier and a built-in rechargeable power pack, which makes it independent from an outside power supply.

When used outdoors, this device will allow accurate coating thickness measurements at temperatures ranging from −20° to 150°F.

Circle No. 239 on Subscriber Service Card

Dipole Feed

A dual polarized dipole feed which includes an extremely low-loss radome has been developed by the Antenna Division of Electronic Specialty Co. The Model 93990 was designed to efficiently illuminate 30- to 60-ft., paraboloids.

The unit operates in the 350-600 mcs range, has a maximum vswr of 2:1 and a minimum of 20 db of cross talk.

Circle No. 240 on Subscriber Service Card

Airborne Transducer

A series of Teleflight pressure transducers, available from Taber Instrument Corp., is designed primarily for space vehicle and rocket applications.

The units are built for low pressure ranges: 0-15, 0-20, 0-30, 0-50, 0-100 and 0-200 psia. They also have fast response to transient pressures and can withstand pressure overloads up to three times full scale without damage or necessity for recalibration.

Models are available for 3mv/volt, 4mv/volt, and 5-v dc full scale systems.

Circle No. 241 on Subscriber Service Card

Miniature Transformer

A miniature differential transformer with a sensitivity of 7 millivolts/mil displacement/volt excitation has been developed by the Control Components Div. of International Resistance Co. The unit is ¼in. in dia. and 0.400 in. long.

The Model 70-3900-S22 is a linear motion, electromechanical transducer, which produces an electrical output proportional to the displacement of the movable core. Input impedance is 320 ohms at 20 kc, and null voltage is less than 0.4 millivolts/volts excitation.

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Injection Laser

Electro Nuclear Laboratories is marketing a family of injection diode sources of both laser and sub-laser (non-coherent) types covering a wide spectrum of wavelengths. Typically, the GaAs Injection Laser operates at 8400 Å and the GaAsP Injection Laser at 6200-8400 Å, depending upon the arsenide to phosphide ratio. Laser thresholds for GaAs range from 1000 to 10,000 amps/sq.cm.

The units cover the following wavelengths: GaP 6,400, Å (at 300°K); GaAs, 9,100 Å; GaAsP, 6,600-9,100 Å, GaSB, 16,000 Å. The devices are relatively monochromatic and emit spectral distributions about 100-200 Å wide.

Circle No. 243 on Subscriber Service Card

Deci-lon Slide Rule

Deci-lon® slide rule is available from Keuffel & Esser Co. in a 5-in. size. The device incorporates a grouping of 26 scales, including new scales based on natural logarithms. The manufacturer states that it is the most complete, functional pocket rule on the market today. Consistent and extended use of colors, functional scale symbols and additional calibrations, K&E says, provide easier and faster slide-rule manipulation.

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UNIVAC

SYSTEMS ENGINEERS
AND
SPECIALISTS

Military systems design requirements at UNIVAC in Saint Paul have created openings for high-level engineers with five to ten years' experience in specific disciplines. These are senior engineer and staff consultant positions with initial assignments in Command and Control Systems or Aerospace Navigation and Guidance Systems. Subsequent assignments may be in the systems design of one of a variety of other military programs based around a central computer or multiple computers.

- DIGITAL SERVO MECHANISMS ENGINEERS
  Engineering degree required with experience in digital servo theory, analog to digital converters, sampled data systems and stable platforms.
- COMMUNICATIONS AND RADAR ENGINEERS
  Engineering degree required with experience in microwave communications and systems analysis of communications networks. Additional experience should include modern radars in complex military systems.
- DISPLAY ENGINEERS
  Science or engineering degree required with experience in displays for Command and Control Systems. These displays should include large screen displays as well as the usual console displays. Additional experience in human factors associated with the design and utilization of displays is desirable.
- MILITARY OPERATIONS ANALYSTS
  Science or engineering degree required with experience in the analysis of military systems for both defensive and offensive uses. Included in the background should be data processing and systems design for operational use of systems similar to the Naval Tactical Data System or SAGE.

Exploratory local interviews may be arranged.

Inquiries will be held in confidence and early replies may be expected.

The above requirements are for our Saint Paul laboratories. Similar requirements exist at our San Diego facility. Submit your qualifications to:

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Encoders/Tachometers

A series of subminiature lightweight photoelectric encoders/tachometers has been developed by Baldwin Electronics, Inc. Series 100 can be used as an encoder for counting increments from a reference for conversion to shaft-angle data, or as a tachometer for measuring rate-of-rotation.

The units consist of four models and can include diametrically positioned readouts and d-c cancellation. Normal output is 600 counts; however 6,000 counts are available with *Phasescan*, an exclusive Baldwin Electronics count multiplying accessory.

Circle No. 245 on Subscriber Service Card

Traveling Wave Tube

Broadband traveling-wave tubes as matched gain tubes are being marketed by the Traveling Wave Tube Product Section of General Electric's Power Tube Department.

The tubes are available from G.E. and cover the frequency range from 2,400 to 20,000 megacycles. ZM-3189 is for use in the 2,400-8,000-mc frequency range. It has a minimum small signal gain of 10 db and minimum power output of five milliwatts. ZM-3191 is designed for the 11,000-20,000-mc frequency range. Small signal gain is 20 db and the power output is 10 milliwatts. The tube is said to withstand shocks of 30 g's for eleven milliseconds and to operate under high vibration levels.

Circle No. 246 on Subscriber Service Card

Microchopper

The Solid State Electronics Corp. has available a Microchopper-Model 10. Solidly encapsulated, the unit will connect and disconnect a load from a signal source. It may also be used as a synchronous demodulator to convert an a-c signal to d-c. Linear switching or chopping of voltages can be accomplished over a wide dynamic range that extends down to a fraction of a millivolt and up to 20 volts, and can be driven from d.c. to 100 kilocycles. Applications include low level voltage measurements, d-c amplifier stabilization, high speed servomechanisms, thermo-couple instrumentation, low level switching.

Circle No. 247 on Subscriber Service Card

Temperature Sensor

Micro Systems, Inc., is marketing a semiconductor Temperature Sensor, ruggedized for severe environments.

The Model TS04C-C1 incorporates integral silicon sensing elements and an all solid-state electronics package for signal conditioning attached to a section of stainless steel tubing. It is designed for use with both conductive and corrosive media in aerospace flight control and telemetry applications requiring unamplified 0-5v dc for specified temperature ranges.

Built for operation with temperatures from —100° to 300°F, the Model TS04C-C1 will withstand vibration of ±50 g's (5 to 2,000 cps) and shock of 60 g's in any direction for 11 milliseconds with no damage or change in calibration.

Circle No. 248 on Subscriber Service Card

X-ray Spectrometer

A simultaneous X-Ray Spectrometer, a fixed channel system that analyzes from one to six elements simultaneously, has been developed by Phillips Electronics Instruments.

Turntable provides for 12 sample holders which can handle solids, liquids, slurries or powders. Flat crystal optics include source and detector collimators, fixed crystal and radiation detector.

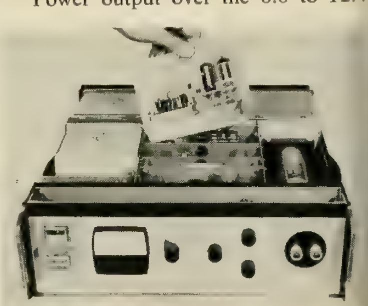
The unit plugs in to any standard 220-v outlet and a 5-kv line voltage regulator compensates for variations in the supply.

Circle No. 249 on Subscriber Service Card

Sweep Oscillator

Huggins Laboratories, Inc., has available an X-band sweep oscillator.

Power output over the 8.0 to 12.4 gc band is variable from 0 to a min. o 50 mw. Rated output power is maintained constant to within ±0.5 db b a feedback leveling loop.



Circle No. 250 on Subscriber Service Card

Teflon Thermal Stripper

Western Electronic Products Co. i marketing the Model "C," designed t strip Teflon wire from #20 to #2 without adjustment. Designed for intermittent stripping, the unit will stri Teflon free from cuts or nicks. Th easily-replaced heated wire loop vaporizes a small ring in the insulation of th wire's circumference, thus, allowing clean nickfree removal of the insul tion.

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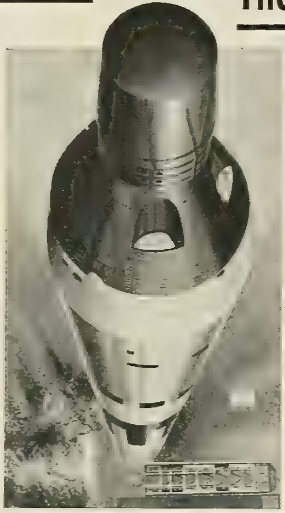

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System Technology Division (STD) engineers at McDonnell provide "Task Force" support for all McDonnell systems engineering. These teams of technical specialists are assigned to specific engineering programs to advance the design and development of space, missile and aircraft products. While so assigned, they continue to receive technical and administrative direction from their functional department within the System Technology Division.

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If you are interested in the diversified opportunities inherent in the McDonnell System Technology Division, complete and mail, in confidence, the brief resume form below. For a comprehensive, immediate review of your qualifications, attach a complete resume of your education and experience.

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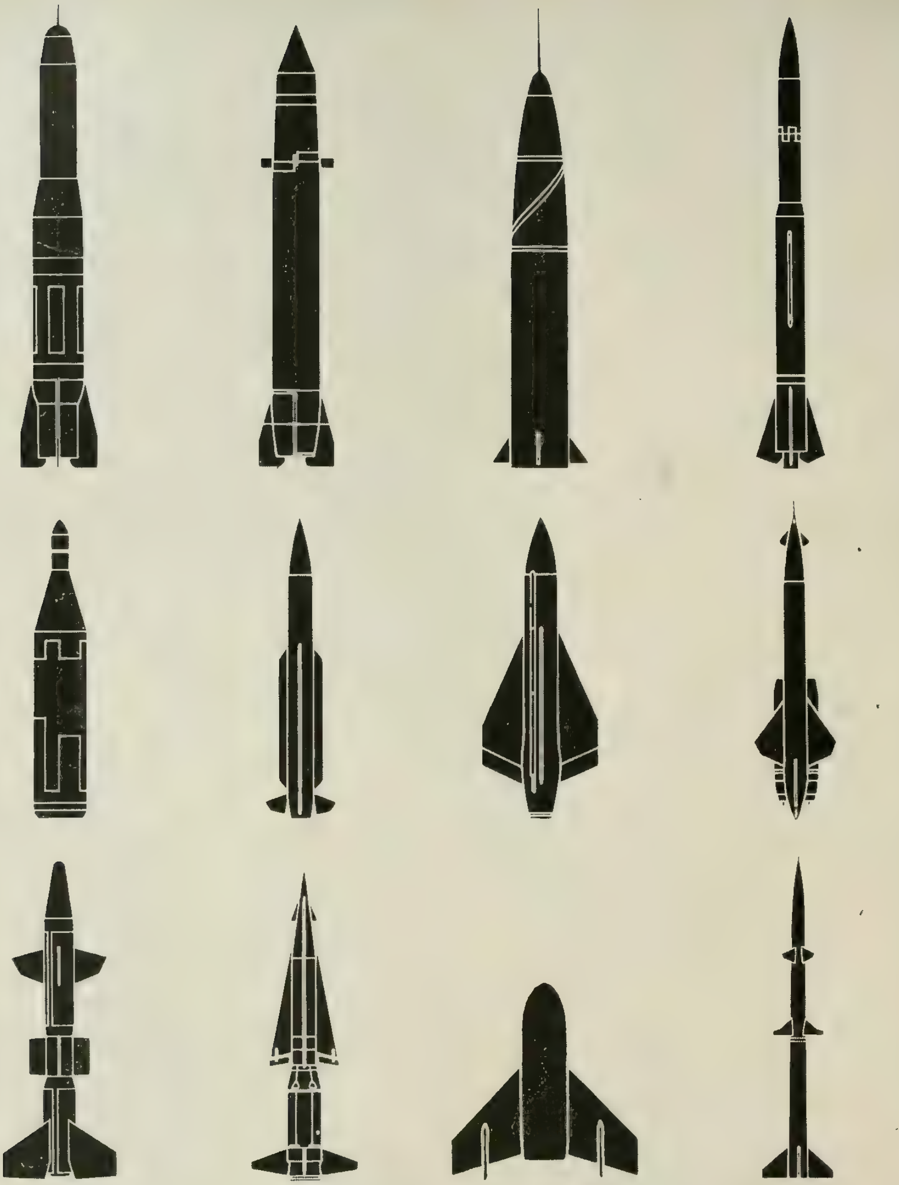

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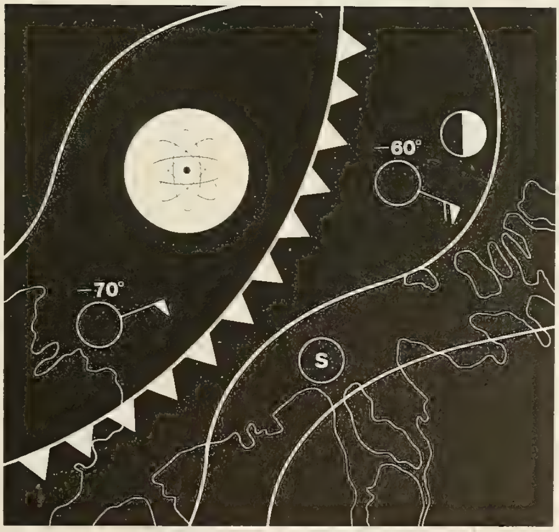

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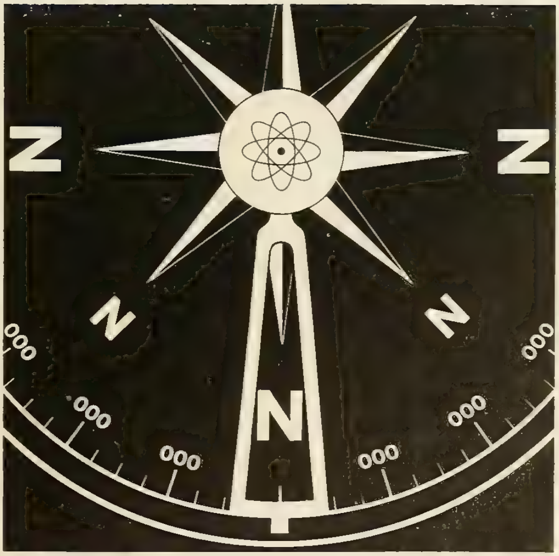

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JULY

Seventh National Conference on Aerospace Education, National Aerospace Education Council, Hotel Deauville, Miami Beach, July 7-11.

IEEE 1963 International Symposium on Space Telecommunications, sponsored by Professional Technical Group on Antennas and Propogation, Boulder Laboratories, National Bureau of Standards, Boulder, Colo., July 9-11.

Meteorological Support for Aerospace Testing and Operation, sponsored by AIAA and American Meteorological Society, Ft. Collins, Colo., July 10-12.

National Association of Power Engineers, National Convention, Everglades Hotel, Miami, July 14-19.

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

The Sixth Annual Institute on Missile Technology, sponsored by the University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News*, University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

963 Cryogenic Engineering Conference, sponsored by NBS Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Correction

The First Annual AIAA Meeting and Exposition will be held at the Sheraton Park Hotel, Washington, D.C., June 29-July 3, 1964—rather than 1963, as erroneously reported in this column in the July 17 issue of M/R.

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A Letter to the Colonel

DEAR COL. LARYONOV:

In an article which appeared in *Red Star,* the Soviet Army newspaper, under your byline on June 1, you refer to the editor of this magazine as an "American madman" for urging this nation to adopt a strong military space program.

We will say at the outset that if this qualifies us as a madman, we will accept the soubriquet. We do indeed, Colonel, favor a strong U.S. military space program. Our regret is that more "madmen" on this side of the ocean do not share the feeling to the same extent that we do. Perhaps you may be interested in our reasons for feeling as we do and exactly what type of military space projects we feel this country should support.

You say in your article:

"Why are the Americans so worried? There is no military danger for the United States in the successful experiments of Soviet science. However, on the other hand, the United States are, in reality, endangering the rest of mankind with their military experiments in space. It is well known that already the first American communication satellites are being utilized as 'spies in the sky'. During the past five years, the United States have spent 2 billion dollars only for the purpose of developing reconnaissance satellites, as for instance, *Discoverer, SAMOS* and *MIDAS.*"

Let us examine your statement, Colonel. What is so dangerous about reconnaissance satellites? Only if a nation has something to hide are such satellites a menace. Our *SAMOS* satellites are not aggressive, they are defensive. No man in the history of the world has ever been killed by a photograph.

And what of our *MIDAS* satellites, which unfortunately are not yet as effective as we would like them to be? The *MIDAS* satellites are early-warning satellites designed to detect the infrared radiation given off by the launch of a ballistic missile. What have you, or other nations of the world, to fear from such a satellite—unless you are planning to launch ballistic missiles at the United States?

No, Colonel, our so-called spy satellites are no menace to you. They are defensive in nature and we wish we had many more of them. We want to keep a close eye on you because we don't trust you—any more than you trust us.

For as long as that state of mutual distrust exists, we hope his nation will adequately fund a military space program for such satellites. That is one part of the military force we support.

For the same reason, we hope the United States will continue to press ahead with *Gemini* and *Dyna-Soar,* which as you have noted are military projects, at least in part. We want this nation to possess the capability to operate and maneuver in space with a manned military police force—to keep an eye on what you are doing up there.

You say in your article: "There is no military danger for the United States in the successful experiments of Soviet science." Frankly, Colonel, we don't want this country to take your word for that. We want the U.S. to be able to inspect what you place in orbit over our heads. If you are not planning any offensive space weapons, then you should have nothing to fear from such an inspection.

So you are correct. We support adequate funding for *Gemini* and *Dyna-Soar.* That is a second part of the U.S. military space program that we see as vital.

We also want to be able to communicate swiftly about the things we discover in space, so we support a program for military communications satellites. Again, there is nothing to fear in such satellites. No one has ever been killed by a telephone.

All of these projects require supporting research into the needs of a military man functioning in space. One aspect of this effort requires research in space itself—and that is why we support the requirement for a manned orbital space station, to study the materials, instrumentation and techniques of space operation.

The final segment of the space program we advocate, Colonel, you will find more sensitive. If we find that your satellites are hostile, if we find they carry offensive weapons, we must be prepared to destroy those weapons. We favor development of this capability; just as we favor development of a space-based A-ICBM system if it proves feasible.

That is the military space program we support for this nation, Colonel Laryonov. We do not support any program to put offensive weapons in orbit. The program we outline is designed to protect us from any aggression on your part. If you intend no such aggression, then there is nothing for you to fear.

WE MIGHT ADD that if you do not support a similar program for the Soviet Union, then you are sadly neglecting your country's defenses. For the distrust, as we noted earlier, is mutual.

We do not trust the Soviety Union for many reasons, Colonel. Your past record of keeping your promises is not exactly spotless. You say in your article:

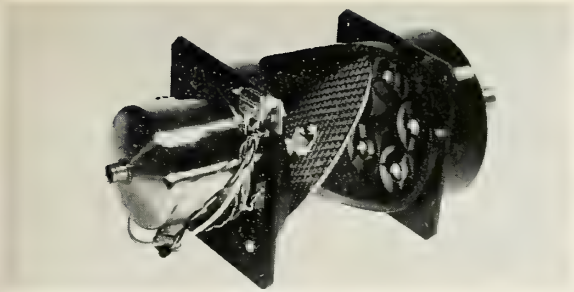
"The madman Coughlin did not even mention the fact that on March 15, 1958, the Soviet Union had proposed to sign an International Agreement to the effect that space research should be limited for scientific purposes only."

We also did not mention the repeated assurances of the Soviet Union that there were no offensive missiles in Cuba.

Please don't misunderstand us, Colonel. The record of this country has not always been spotless in the past. We can understand why you mistrust us. It is a natural fear; we, too, have our own national interests and, indeed our own extremists.

But until the mutual distrust dissolves, we support a healthy military space program intended solely for the defense of our country. We think you might be wise to do the same. Who knows when the Chinese will put up their first spacecraft?

William J. Coughlin
Editor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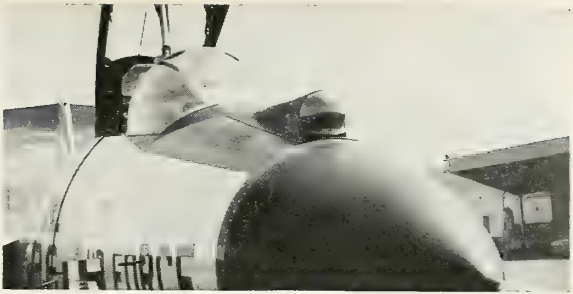
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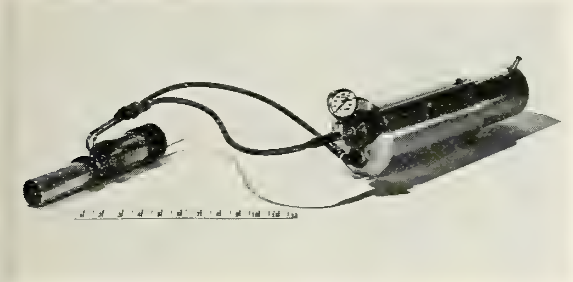
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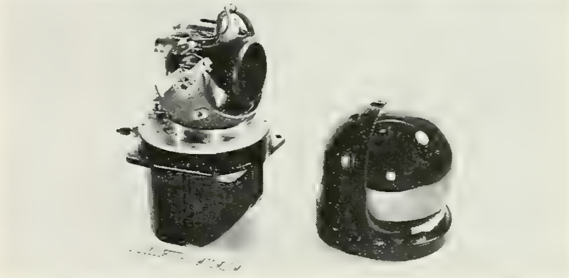
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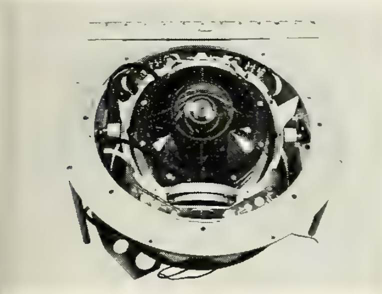
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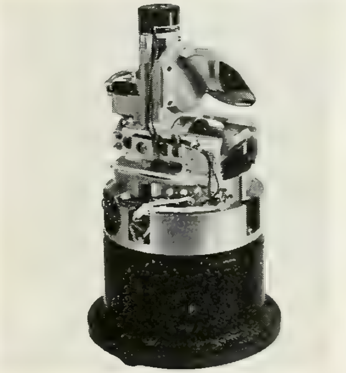
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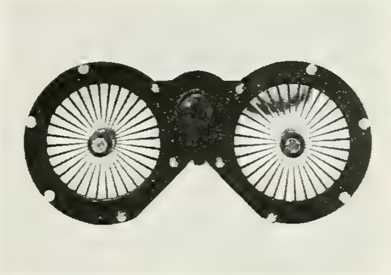
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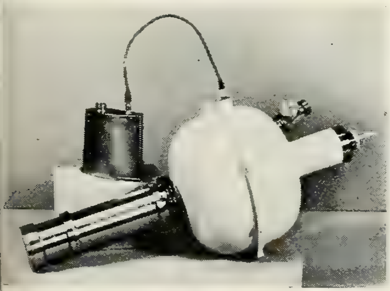
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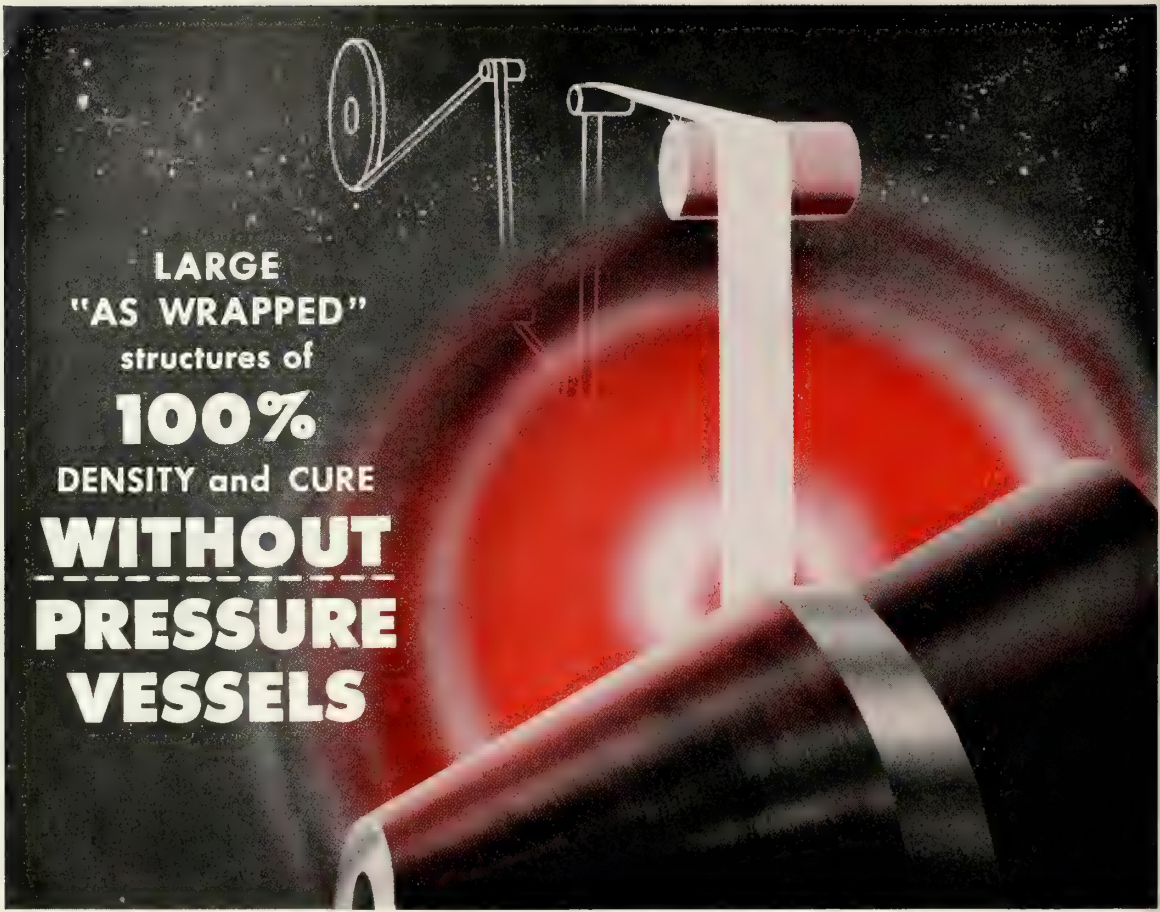

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THE COVER

Satellite motion simulator at Westinghouse Air Arm Div., Baltimore, is used to test a new satellite attitude control system. The 1500-lb. unit is delicately balanced on 12-in.-dia. stainless-steel air bearing. Bursts from air jets change attitude of table.

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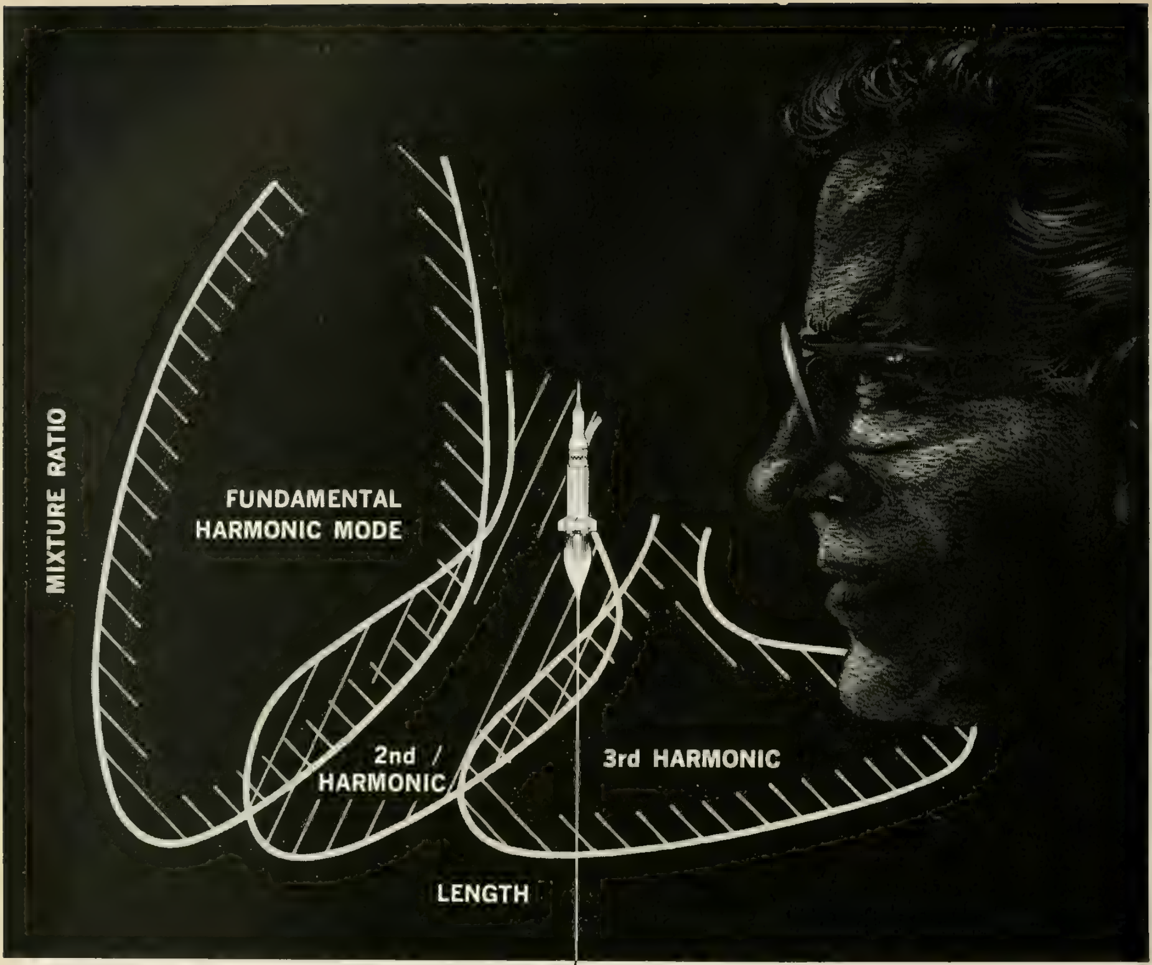

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letters

Ordnance in Perspective

To the Editor:

It was very refreshing as well as informative to read the article by John F. Judge ("Explosive Ordnance Systems Approach Advocated," M/R, May 27, p. 41) on the status of solid-propellant (ordnance) components as they are utilized and employed on missile systems. His attempt to elevate their stature within company organizations is timely and a long-delayed statement of fact.

This subsystem has been very much neglected in the past—especially, within the areas of system logistics and site activation operations.

The Non-Electric Stimulus Transfer System (NESTS), as well as the Exploding Bridgewire (XB) system are excellent systems not only from the standpoint of operational efficiency and maintenance but also from the viewpoint of weight saving, which we all know is a critical factor within certain areas of the missile system.

It is hoped by the writer that in the future the companies concerned will see fit to separate the solid-propellant components system, along with their associated design specialists (who should be ex-"powder monkeys," "gun plumbers," and "underwater demolition frog-feet types"), from the avionics sections to which they are generally attached—thus establishing the art in its proper perspective and importance with respect to other missile subsystems. Solid-propellant components as utilized on missile systems are here to stay, so let us hope that the companies and organizations concerned will push for the establishment of such a separate organization.

May I compliment Mr. Judge for an excellent article—and hope to read additional articles in M/R on this important subject?

J. C. Lewis
Denver

Our Limited Resources

To the Editor:

It is regrettable that you used your May 13 editorial, "The Other Side of Space," which was intended to eulogize the late Dr. Theodore von Karman, as a vehicle for expressing some of your partisan views regarding the lunar program. Surely Dr. von Karman was not a person to confuse issues in this manner.

Turning from your appreciation of the past to your concern for the future, it is also regrettable, in my view, that you continue to favor—casting aspersions all the while—the most transparent argument in support of the *Apollo* program. You state that "this country is wealthy enough to fund amply, on its own merits, any program it regards as essential."

It would appear that you share the all-too-prevalent confusion between dollars and resources. Although we may be able to afford the "additional dime for these other pet projects," there is every reason to doubt that we have the total resources to support such projects. The scientists and engineers that are attracted by the glamour (and money) of the space program are, so to speak, taken out of circulation. Our supply of manpower and facilities is definitely limited; a strong emphasis on space must have the effect of sharply diminishing the efforts that will be directed to the many scientific and engineering fields that are more likely to benefit our total population—indeed, all mankind. The list of such fields is a long and obvious one and need not be repeated again.

Incisive comment on the current lunar "debate" must consist of more penetrating remarks than simply attributing "uncommon good sense" to those who agree with you and ascribing "muddle-headed thinking" to those who do not.

Richard P. Schuster, Jr.
Pasadena, Calif.

Aerospace Simulators

To the Editor:

Reference is made to your article, "Demands of Environmental Testing Spur Industry" (M/R, May 20). On page 76, in the last paragraph, there is a statement starting: "One of the most comprehensive solar radiation simulators available is built . . ." to which we must take strong exception. The equipment in question is being manufactured by ourselves—i.e., Aerospace Controls Corporation—and *not* Tenney Engineering, who are our sales agents for standard laboratory-type solar simulators only. Since the simulation system in question is probably the most advanced and most successful, practical equipment available, the statement in your article is damaging and detrimental to our interest in that it gives credit for its development and manufacture to a company other than ourselves.

As we are the only independent company in the United States exclusively devoted to the design, development and manufacture of solar simulation systems, we would appreciate it very much if you could set the record straight.

Alfred Landau
General Manager
Aerospace Controls Corp.
Santa Monica, Calif.

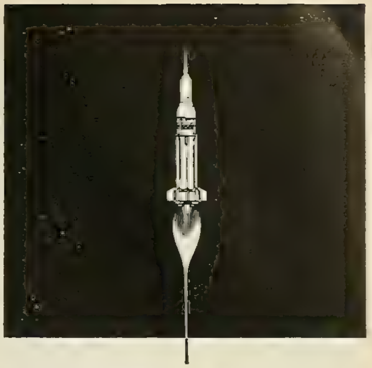
M/R should have said the simulator can be purchased *from Tenney Engineering, rather than that it is* built *by Tenney. Aerospace Controls Corp. manufactures the simulator in question, as well as seven other standard models.—Ed.*

Happy Landings

To the Editor:

I trust implicitly in the U.S. scientific and technical capability to place a man on the Moon in this decade safely—provided he isn't injured landing amidst all those vodka bottles.

Ray Benton
Baltimore



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Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES

Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

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Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

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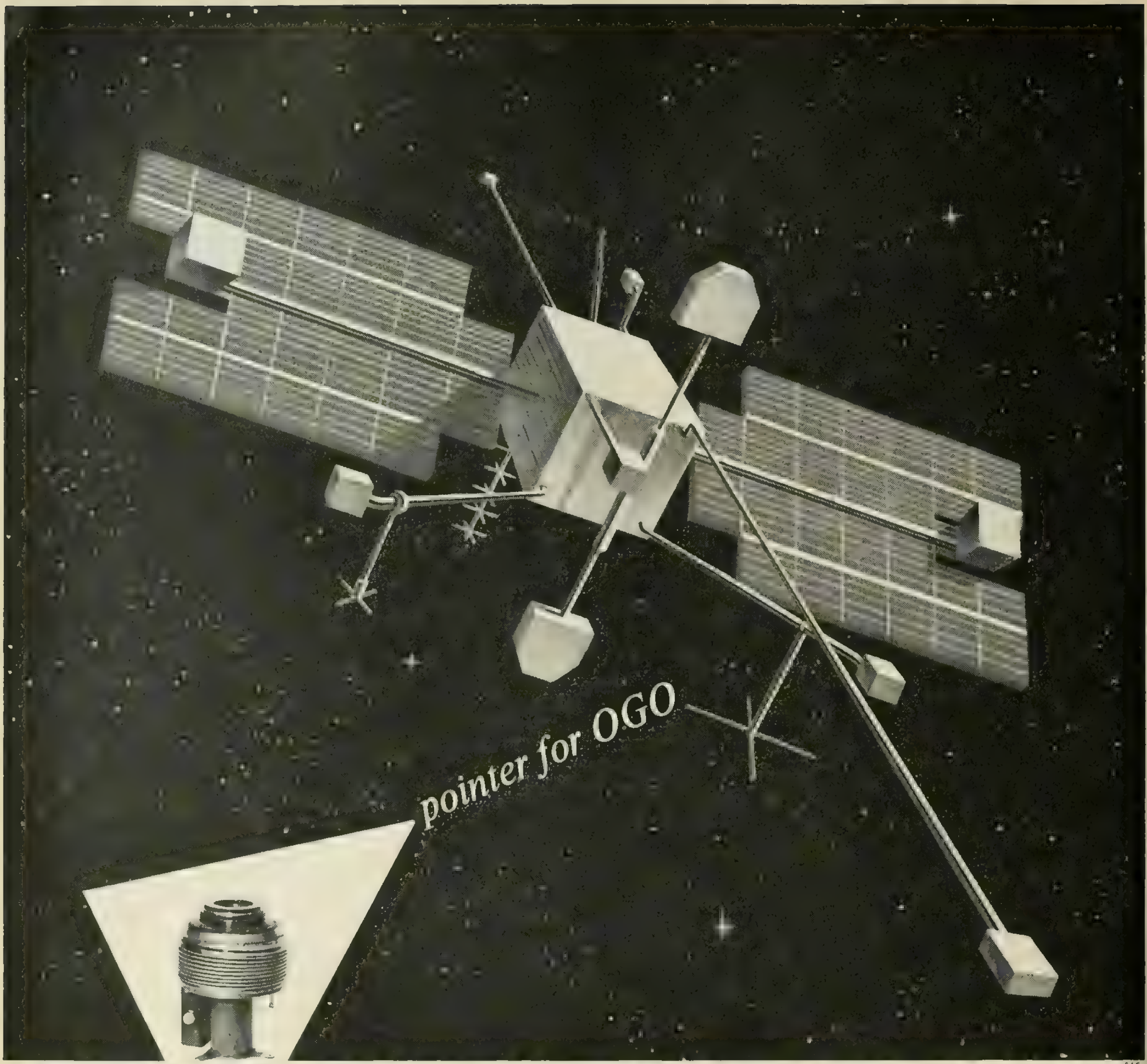

Once in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three directions. Some of its experimental packages must line up perpendicular to the sun's rays. Other experiments must turn to face the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar arrays in continuous orientation with the sun; a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional high-speed servo-motor without the usual problems of gear lubrication. It does its work by wabble or twist motion at a rate of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include building OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ARPA, and continuing Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Dept. B-71, Redondo Beach, California or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Bad Harbinger for Dyna-Soar

House Space Committee recommendation that NASA close its Flight Research Center at the end of Fiscal '65 casts dark shadows over the *X20's* future. Committee said it received testimony which confirmed that there are no firm future projects involving high-speed research aircraft beyond the current *X-15* program, which will end in Fiscal '65. This raises doubts about whether NASA really expects to participate in *Dyna-Soar*—and about DOD plans for the manned re-entry spacecraft. Air Force *X-20* flights had been expected to use, at least in part, Flight Research Center facilities.

New Missile Tags Drawn Up

Pentagon is about to redesignate all military missile systems to eliminate confusing and uninformative multi-digit numbers. However, like the recent redesignation of aircraft, the missile changes will involve numbers only and not popular names.

Holmes Resignation Repercussions

Officials of NASA's Office of Manned Space Flight were shocked and disappointed by D. Brainerd Holmes' resignation. Many of them say that it might have been better for the project if space agency director Webb had quit instead. So far, no other officials have indicated any plans to resign. Holmes, at a recent meeting, made a special plea to his staff to forget the management flareup and concentrate on keeping Projects *Gemini* and *Apollo* moving.

A Rose by Any Other Name

Air Force was ordered to change the name of *Dyna-Soar* to *X-20* in order to create the image of a purely experimental research craft rather than a weapon system. Top DOD officials felt the *Dyna-Soar* name had been too tightly connected with the concept of an orbiting space bomber.

Goddard Tightens Quality Control

NASA's Goddard Space Flight Center is initiating a stringent spacecraft quality-assurance program aimed at even the lowest-tier subcontractor. In a sweeping move which will apply to all Goddard spacecraft scheduled to fly after next March, quality standards will be prepared by Goddard program managers. The *Nimbus* manager, for example, will set up his standards; after review by a six-man council of key personnel representing the Center's major functions, the standards will be written into the spacecraft contract. "For the first time, our quality-assurance program is going down literally to the nuts-and-bolts level," a Goddard spokesman said. Specifications will be made tougher, performance will be spelled out, and subcontractor items will have to meet NASA or military specifications.

Hound Dog Learns New Tricks

Air Proving Ground at Eglin AFB, Fla., now is conducting a follow-on *Hound Dog* test program to develop low-level capabilities of the North American air-to-surface missile.

INDUSTRY

P&W Likely Fluorine Choice

Pratt & Whitney is expected to be picked by NASA to develop the experimental liquid fluorine engine funded in the Fiscal '64 budget. Program recently got a big push when Rep. James Fulton (R-Pa.) pushed through an amendment to NASA's authorization bill which added $2 million to the high-energy propulsion research programs.

Cape Veteran Promoted Away

B. G. MacNabb, General Dynamics/Astronautics manager at Cape Canaveral for past six years, has been promoted to director of engineering tests for all GD/A activities. He will leave within a few weeks for San Diego, and will be replaced by Ken Newton. MacNabb served longer at the Cape than any other base manager, and was in charge of all *Atlas* R&D work at the Cape and later use of *Atlas* as a space booster in *Mercury* and other programs.

Small Business Confab at MSC

NASA's Manned Spacecraft Center will hold second annual Industry Assistance and Small Buisness Opportunity Symposium at Rice University, Houston, on July 30. North American Aviation and McDonnell Aircraft will have a panel. Grumman, NAA, McDonnell, GE, Lockheed, Raytheon, Aerojet-General, General Dynamics and Philco all will have exhibits on what they're in the market for from small business.

INTERNATIONAL

Missile Interest Swells in Japan

Five Japanese industrial combines are trying to sell the Japanese Defense Agency on a plan to produce all-Japanese versions of the U.S. *Mauler* and *Bomarc* weapon systems. Shin Mitsubishi, Mitsubishi Electric Manufacturing Co., Toshiba, Nippon Electric Co., and Kawasaki Aircraft Co. expect to produce other short-range missiles. Meantime, Japan's Self-Defense Force is scheduled to receive a supply of U.S.-built *Hawk* missiles during the fourth quarter of FY '64. Initial Japanese *Hawk* battalion is to be set up at Shimamatsu, Hokkaido, in the summer of 1965, after training at U.S. Army schools in this country.

No Cooperation without Commitment

NASA will be forced to delay some of its planned international cooperation programs until firm commitments are reached with the nations involved. House Space Committee killed a $4-million budget request for follow-on satellites until NASA has an idea just what purposes will be served.

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The Missile/Space Week

NASA Picks Dixon Successor

Earl D. Hilburn has been named by NASA as its new Deputy Associate Administrator.

Hilburn, currently vice president and general manager of Curtiss-Wright Corp.'s Electronics Division, will fill the position left vacant by the resignation of Thomas F. Dixon who returned to North American Aviation Inc.

As Deputy to Associate Administrator Dr. Robert C. Seamans, he will be responsible for overall management direction of all NASA programs other than manned spaceflight. He will exercise a similar function over all NASA centers not concerned with the manned space flight projects.

In another action, Robert W. Long was appointed as a consultant to Seamans on construction matters. He was president of a Kansas construction company.

Titan III Segment Fired

A segment of *Titan III's* big solid-propellant booster rocket motor has undergone the second test firing at United Technology Center's Coyote, Calif., test site.

Five such motors will be combined in one huge motor to be test-fired in the near future. The big five-segment motor will make up the first stage of the *Titan III.*

MSC To Get Space Platform

A frictionless platform being built by The Martin Co., Baltimore, under a $22,386 NASA contract will be used by the Manned Spacecraft Center, Houston, to evaluate space suits, stabilization devices, tethering lines and maintenance tools for use in space.

The platform will simulate the "five degrees of freedom" or the forces exerted by an astronaut working in free space.

The 175-lb. simulator will be lifted from the floor on a compressed air cushion forced through three legs at 21 psi. This pressure will suspend the platform 0.005 in. above the floor, and is sufficient to support the simulator's own weight plus 300 lbs. NASA says. This is equivalent to the weight of a spacesuit-clad man and portable back-pack environmental control system equipment.

The five degrees of freedom duplicated by the platform are pitch, yaw and roll, plus two on the horizontal plane—forward-backward and side-to-side. The unit is due at MSC late this year.

USSR Shots Disclosed

A Soviet spacecraft launched last Oct. 24 went into orbit in 24 separate pieces according to North American Air Defense Command information just released in a report by NASA's Goddard Space Flight Center.

First pieces began falling from orbit five days after launch; the last re-entered Earth's atmosphere Feb. 26. It is not known if the vehicle was manned or if it fragmented by design or accident.

Other unannounced Soviet shots listed in the NASA-NORAD summary include:

- Jan. 4, '63—a three-section satellite, the largest section of which fell from orbit in one day; other two after a week.
- Sept. 12, '62—a seven-section satellite, whose sections fell out of orbit separately over a period of five days.
- Nov. 4, '62—five fragments, which dropped out of orbit in November, December and January.

Moon Base Studies Pending

NASA is expected to award a four-month engineering study contract soon on the manned lunar-surface base concept. Six firms have made technical presentations to the space agency, and ten have responded to NASA's request for proposal.

The base is to consist of a group of prefabricated modules to be carried to the moon on *Saturn V* and assembled there either on or below the surface. It is to support a range of scientific missions.

Responding to NASA's RFP were: Boeing, General Electric, General Dynamics/Astronautics, Westinghouse, Grumann, Lockheed, North American, General Motors, Martin Aerojet-General and Goodyear.

Lance Undergoes Inspection

The Army has submitted it *Lance* missile system to the scrutin of more than 200 missile expert from the Defense Department an industry for three days as part of th

Engineering Concept Review.

Lance, now in early development, was run through a classified wringer for technical review by Army's Combat Developments Command, Artillery Board, Continental Army Command, and almost all other commodity command as well as other Army and contractor personnel.

Full-scale operational mockups were used to demonstrate the concept, and Army says it was the first time such full-scale operational mockups of all components of a weapon system were available for such a technical review.

ASP Study Contracts Let

Air Force has awarded contracts to three firms for investigation of *Aerospace Plane* concepts. The contracts, for $500,000 each, went to General Dynamics/Astronautics, North American Aviation and Douglas Aircraft.

The vehicle would use the liquid ir cycle concept, where a ramjet-like ngine with open intake scoop would ropel the vehicle through the atmoshere, simultaneously gathering and iquefying oxygen.

After leaving the atmosphere, the ngine, with intake port closed, would ct as a rocket using the liquid oxyen previously gathered with a liqid hydrogen fuel supply.

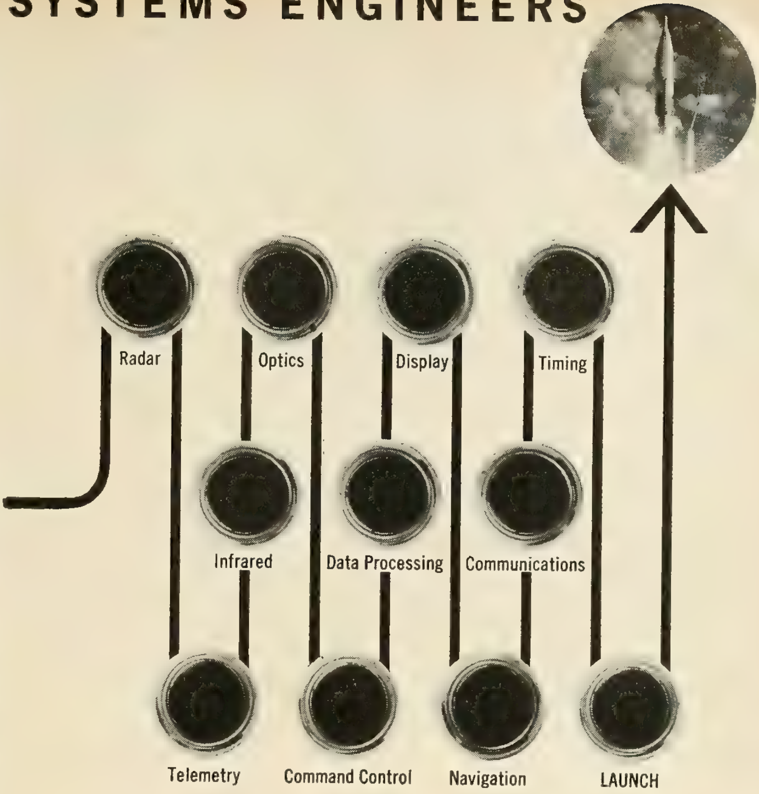
The contracts are the first awarded or work on the vehicle itself, alhough previous contracts have been et for propulsion systems. The *Aeropace Plane* would take off from a onventional runway, go directly into pace, and return to land at the aireld just as a commercial airliner. iggest promise in the concept is limination of one-shot rocket boostrs in favor of frequently re-useable ehicles able to re-supply orbiting pacecraft or act as inspectors of susicious objects in space.

The current contracts are not a mmitment to build the vehicle, Air orce, said, but are merely "to adance the state of the art."

idas Plays Trump

Air Force has undertaken a series high-altitude probe launches to lp develop better detection equipent for its *Midas* satellite-borne rly warning system. Designated *ump,* the series will use a *Nikevelin* vehicle launched from Eglin FB to study the radiation signares of ICBMs launched from Cape naveral. The *Nike-Javelin* will rry an ultraviolet radiometer to

SYSTEMS ENGINEERS



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make photometric measurements of ICBM plumes.

The Air Proving Ground Center, conducting the program, is replacing the formerly-used *Nike-Cajun* rocket with the *Nike-Javelin* and a new APGC-designed IR detection payload.

Almost two years in the making, *Trump* had its first launching from Eglin's Santa Rosa island facility May 29. The 27-ft.-long vehicle, weighing 1850 lbs., reached an altitude of 430,000 ft. and impacted 50 miles down the Eglin Gulf Test Range.

Shots of the Week

The *Polaris A3* achieved a second seagoing success June 21 when it was launched from the USS Observation Island near Cape Canaveral. The missile was fired more than 1,500 miles into the Atlantic Missile Range.

Other shots of the week:

- A *Titan II* ICBM firing from a concrete silo at Vandenberg AFB, Calif., June 20 was termed a success. Range and target of the missile were not disclosed. It was the third consecutive *Titan II* success from Vandenberg.
- In another flight in a series studying air friction heating, the *X-15* rocket plane reached a maximum speed of 3,750 mph June 25 over Edwards AFB, Calif. The plane was equipped with a special "traversing probe," which measured heat generated by friction at various points on the craft's skin.

Titan III Pad Awards Let

The U. S. Army Corps of Engineers has awarded two contracts totaling more than $13.4 million for construction work in the Cape Canaveral-Merritt Island area.

C. H. Leavell & Co. and Peter Kiewit Sons' Co., both of El Paso, Tex., won a $12,678,294 pact to install launch pads and mobile service towers on *Titan III* Complexes 40 and 41 at Cape Canaveral.

The contract calls for installation of railroad tracks for the service towers, umbilical towers, fuel holding areas, support buildings and other facilities. Complex 40 also will have facilities for liquid hydrogen. Complex 40 must be completed by Sept. 1, 1964, and Complex 41 by Dec. 30, 1964.

Bids will be opened July 17 for additional facilities for the *Titan III* launch complexes. These will include roads, railroad and transporter rail trackage, receiver building for vehicles and boosters, and a vertical integration building.

A second contract awarded last week by the Engineers went to J. Hilbert Sapp, Inc., Orlando, Fla., for installation of a primary water system to serve NASA's Merritt Island facilities. The eight-mile long water line will cost $752,155.

SLAM Gets New Life

Award of a $10-million contract to Ling-Temco-Vought, Inc., has brought new life to the sluggish program to develop a supersonic low-altitude missile (*SLAM*).

The award, for "continued development of technology", was for a renamed "low altitude supersonic vehicle," which could use either nuclear or chemical fuels.

Nuclear powerplants, being developed in the Pluto program, are greatly preferred by the Air Force and Navy because of the tremendous range they would allow, but nuclear fallout has been a nagging problem. The use of chemical fuel would eliminate the fallout problem but slash the range.

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Garrett Founder Dies

J. C. "Cliff" Garrett, president and founder of The Garrett Corp. and AiResearch Manufacturing Co., died unexpectedly June 21 at his Beverly Hills, Calif., home.

Mr. Garrett, born in Seattle in 1908, was a pioneer in pressurizing and air-conditioning aircraft and spacecraft.

Founded in 1936, The Garrett Corp. manufactures more than 2,000 different products for the aerospace and other industries.

Mr. Garrett set up AiResearch in 1939, recognizing the need for high-altitude vehicles to carry their own artificial atmosphere and pressure.

Some of his concepts continue to find application in environmental systems for U.S. manned space vehicles.

Mr. Garrett was a past chairman of the board of governors of the Aerospace Industries Assn., a member of the Society of Automotive Engineers and the Institute of Aeronautical Sciences.

Surviving are his wife, a daughter and a brother.

EIA Chief Calls for Unity

Charles F. Horne, recently re-elected president of the Electronic Industries Association, has warned that the EIA "may well disintegrate into a heterogeneous assembly of manufacturing groups" unless it concentrates on developing greater unity.

Horne, president of General Dynamics/Pomona, told the annual EIA membership luncheon in Chicago that "our greatest threat, as an industry and as an association, is that we may be fragmented by our diversities of interests and products. Yet our strength lies in a history of working together in our mutual interests."

He suggested that EIA should consider adopting the role of a modified federation in which it would affiliate with regional and special-product groups while acting as the industries' national spokesman.

Surveyor Rover Bids Asked

NASA has begun procurement action leading to the development of a roving payload for the *Surveyor* lunar soft-landing spacecraft.

Some 22 firms were invited to a June 28 bidders conference at Jet Propulsion Laboratory.

The firms were briefed on Phase I of the project, which calls for funding two or three firms for a design competition program, and will last six months.

The firms will each build an engineering model. In phase II, NASA will run the models through a rigorous test program to determine the best design. Phase III covers actual development of the roving vehicle with a goal of having an operational payload for *Surveyor* missions in the first half of 1966.

The roving vehicle—with a weight of about 100 lbs.—will be expected to extend the range of *Surveyor* scientific measurements as well as collect data on landing sites for Project *Apollo.*

Avco Gets Engine Contract

Avco Corp. Research and Advanced Development Div. has won a $121,810 contract for development of a two to three kilowatt wire resisto-jet engine that is being considered for orbital transfer of 500 to 1,200-lb. spacecraft.

This is the first development contract awarded for the eletrothermal engine pioneered by NASA's Lewis Research Center. The contract calls for significant advances in reliability, endurance, and performance.

The resisto-jet engine is similar in some respects to a conventional chemical rocket. Although the propellant does not burn, it is heated to high temperatures by flowing it over an electrically heated wire and expelling it through a nozzle to produce thrust.

Avco Corp. officials said the resisto-jet is being considered for orbital transfer missions because it can produce more than twice the exhaust velocity of chemical rockets at high operating efficiencies.

Low Bidder at Cape Named

A. S. Wikstrom, Inc., Skaneateles, N. Y., is the apparent low bidder at $2,386,250.42 to install 18 miles of railroad tracks to serve NASA's Merritt Island industrial area and the *Saturn V* launch Complex 39.

Three firms submitted bids on the job, which was estimated by the Corps of Engineers to cost approximately $2.5 million.

The rail lines will link the marshalling yards on North Merritt Island with the two areas and permit direct rail delivery of heavy structural steel to construction sites.

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

Rocket nozzles and convergent-divergent cones made of Great Lakes Carbon Corporation's **HLM-85** grade graphite are standard in the first stage solid propellant motor developed by Thiokol Chemical for the Minuteman missile.

GLC's **HLM-85** graphite is distinguished by high density, great erosion resistance and economy of performance.

HLM-85 graphite is in full production. Ample supplies are available in a wide choice of sizes and shapes.

Exotic grades of GLC graphite are also being developed in our research laboratories to meet advanced applications in aerospace technology. Your inquiry is cordially invited and will receive immediate attention.

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Photo by Thiokol Chemical Corporation

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Before America's first manned space station goes into orbit, a whole new generation of problems will have to be met and solved.

To keep the crew in good health, for instance, we'll have to maintain their Earthlike environment for months or years. We'll have to devise a supply system to get food, air, and all the other necessities up to them regularly. We'll have to keep all their equipment in operating condition. We'll have to be able to work on the outside as well as the inside of the station. We'll have to develop vehicles and techniques for shuttling personnel to and from the station, as well as for in-space rescue.

Lockheed-California foresaw the scope of these problems five years ago, and brought together a team of scientists and engineers to specialize in man-in-space. The SpaceCraft Organization has developed a high degree of capability in all aspects of space station design. They have conducted extensive studies of techniques and vehicle designs for supply, maintenance, rescue and logistics in space. Today they stand ready to undertake the many vital tasks upcoming in this challenging new age of man-in-space.

LOCKHEED-CALIFORNIA COMPANY

A Division of Lockheed Aircraft Corporation, Burbank, California

By House Space Committee . . .

NASA Cut Nearly $500 Million

Appropriations Committee could trim requests even further; Apollo hit hardest; closing of FRC in FY '65 urged

by Hal Taylor

THE HOUSE Space Committee last week approved Fiscal 1964 budget reductions of $259.2 million in the Office of Manned Space Flight and $136.2 million in Space Sciences and Advanced Research and Technology programs.

The committee was also expected to approve a $96.5-million reduction in the communication satellite and tracking and data-acquisition programs.

This would reduce NASA's overall $5.7-billion request by $491.9 million and leave the space agency with an authorized budget of funding of $5.2 billion for Fiscal '64 (M/R, June 10, p. 18).

The committee's approval of the almost $500-million reduction is expected to help clear the way for approval by an economy-minded House of Representatives when the legislation is brought up for debate in the next two weeks before going to the Senate for final approval.

Even further reduction in the budget is possible in the House Appropriations Committee, which actually votes the amount of money NASA can spend in any one year. The action of the Space Committee—which simply authorizes NASA to engage in certain programs, but does not provide the money—may dull the budget-cutting shears of the Appropriations Committee.

- **Top slash**—The large slice out of the Manned Space Flight request was approved with only one dissenting vote.

The $259.2-million reduction included $183.7 million in research and development and $75.42 million in new facility construction funding.

Hardest hit was the *Apollo* spacecraft program, which was reduced by $120 million. The $1-billion request for launch vehicle development and the $302-million request for Project *Gemini* were approved in full.

The committee approved a $89.2-million reduction in the Office of Space Sciences' $737.9-million R&D request and trimmed its $25.5-million construction budget by $7.7 million.

- **AR&T**—Its action on the office of Advanced Research and Technology budget included cutting $18.5 million from its $331.2 million R&D program budget and $20.8 million from its $78.2-million construction request.

The committee's action killed two programs, including the *Surveyor Orbiter* spacecraft and Project Fire advanced re-entry project.

It also recommended that NASA close its Flight Research Center at Edwards AFB, Calif., because the *X-15* program would end in Fiscal 1965 and no future aircraft program will require use of the center.

It approved $3.9 million for NASA's Electronics Research Center in Boston, but the committee report ordered NASA to completely restudy the need for the Center. It ordered the space agency to submit the report to the space committees of both houses of Congress by Feb. 1, 1964. If either committee then objects the budget request will be killed.

In another surprising action, the committee voted to add $2 million which NASA had not requested—for further development of a high-energy propulsion program.

- **Manned Spaceflight**—In reducing the $1.2-billion request for the *Apollo* spacecraft by 10% or $120 million, the committee said there was a question whether NASA could use such a large amount of money in one year, particularly in connection with the $661-million request for the development of the Command and Service Modules.

The $45-million request for the M-1 engine was reduced by $30 million because there is no specific mission for the liquid hydrogen-powered engine.

- **Building cutback**—The reduction in construction was spread through almost all the projects in the manned spaceflight area. Only 19 out of 67 projects received the full requested funding. Six projects, however, were dropped completely; these included expansion of computation facilities, an extension to the propulsion and vehicle engineering lab, and a support operations building at Marshall Space Flight Center. Other projects killed are security control facilities at the Mississippi Test Facility, and a Calibrations and Standards Laboratory and Vehicle Maintenance and Service facilities at the Launch Operations Center.

- **Applications & Tracking**—Although the committee had not completed action on this portion of the budget, Rep. Ken Hechler (D-W.Va.) told MISSILES AND ROCKETS the budget for the two programs would be reduced by $96.5 million. ■

NASA BUDGET REDUCTIONS
(in millions of dollars)

PROGRAM	FISCAL '64 REQUEST	APPROVED
Manned Spaceflight		
Apollo	$1,200	$1,080
M-1 Engine	$45	$15
Integration & Checkout	$153	$125
Aerospace Medicine	$16.7	$11
Manned Space Flight Construction		
Manned Spacecraft Center	$37.7	$35.1
White Sands LEM Test Facility	$15	$11.5
Marshall	$38.4	$28.98
Michoud Plant	$10.0	$8.688
Mississippi Test Facility	$111.69	$92.69
Various Locations	$44.4	$38.1
Launch Operation Center	$307.1	$273.99
Space Sciences		
Follow-on Internal Satellites	$4	0
Ranger	$90	$65
Surveyor Orbiter	$28.2	0
Mariner	$100	$85
Bioscience	$35.2	$21.2
Supporting R&T for launch vehicle development	$5	$2
Construction	$25.5	$17.8
Office of Advanced Research and Technology		
Advanced Fire	$8.5	0
Human Factor Systems	$18.2	$13.2
Project Rover	$96.7	$91.7
Construction	$78.2	$57.4

Leaving $47 billion . . .

House Lops Nearly Two Billion from DOD Funds

Largest cut in five years aimed partly at forcing better procurement, plans; $98 million added for Dyna-Soar

by Heather M. David

THE DEPARTMENT of Defense's Fiscal 1964 budget has cleared the House of Representatives after receiving the largest dollar and percentage cuts made in any budget since 1958.

In a 410 to 1 vote, the House passed Appropriations Committee recommendations trimming almost $2 billion from the budget request of $49,014,237,000. This leaves a sum of a little more than $47 billion, less than last year's budget by $1.23 billion.

Although debate on the House floor expressed the concern of some Congressmen about the lack of a manned military space program, the bill leaves a proviso by which Secretary of Defense McNamara may use *Dyna-Soar* funds for Mach 3 aircraft if he so desires. The committee's report stated that among reasons for this action was McNamara's de-emphasis of *Dyna-Soar* in House testimony.

The committee appropriated $98 million for *Dyna-Soar*, and gave *DOD* permission to lump this with $27 million from FY '63 *Dyna-Soar* funds for use on either program. However, it made very clear that the funds could not be reprogrammed for other military manned space effort.

- **Economy moves**—A good percentage of the budget slash is aimed at enforcing better procurement actions and efficient planning moves by DOD. The House called for a cut of about $365 million in reductions "based on overestimates, greater economy and efficiency. . ." This included across-the-board cuts of 1% in procurement actions and 3% in research, development, test and evaluation. Some $364 million was deleted by bookkeeping transfers and other changes. Thus, the Appropriations Committee was responsible for cutting $744 million in program money, in addition to the authorization deletion of $408 million. The budget now travels to the Senate, which traditionally restores about half the House cuts.

- **Major cuts**—The Army's request for *Mauler* surface-to-air missiles and related test equipment was totally wiped out, at $96.3 million. The committee pointed out that the missile is still in very early development and is already encountering slippages.

The Air Force's *Mobile Mid-Range Ballistic Missile* (*MMRBM*) program was cut by $100 million, leaving only $43 million next year. The committee charged that since the program definition phase has not been completed, no cost estimates can now be made. It also expressed the fear that if the money were appropriated, efforts would be made by DOD to reprogram it to other functions.

A $47.5-million reduction was made in electronics and telecommunications systems and related equipment programs not associated with specific aircraft and missiles. The committee rapped procurement policies in this field, saying "the prevailing attitude on the part of too many responsible officials seems to be to wait until well into the production cycle before obtaining adequate plans and specifications for competitive procurement."

- **Procurement cuts**—Total cuts in Army missiles and related equipment were $233 million, bringing the total appropriation to $2.969 billion. The multi-system test equipment deleted with *Mauler* also would have served *Shillelagh* and *Lance*, but the committee pointed out that "cost estimates and procurement plans in the early stages of R&D and engineering development cannot be regarded as firm." However, it added that it had no objection to utilization of an DOD emergency fund of $150 million if sufficient breakthroughs occur in the development cycle and realistic procurement plans and specifications can be developed.

The Navy's request for procurement funds was cut $188.5 million from budget estimates, leaving $2.877 billion. *Mauler* funds in this category were also deleted, amounting to $11 million for installation of the *Sea Mauler* on certain destroyers.

The *Typhon* surface-to-air missile, encountering development problems, was reduced by $1.3 million, holding missile procurement until the research and development cycle is further and more satisfactorily advanced.

Marine Corps procurement was cut by $5.7 million to $202 million.

Air Force missile procurement was cut $47.5 million, bringing that figure to $2.129 billion. Of this, $15 million accounts for cuts made in the belief that the changing nature of the missile program will free funds from some projects which can be applied to others.

The committee also reduced $1 million for missile industrial facilities, bringing that appropriation to $11 million. Other Air Force procurement, including electronics and communications equipment, took a slash of $80.2 million, to a recommended $871.3 million.

- **RDT&E**—The committee conceded that there is great difficulty in estimating research and development funds, and the overall estimate can be little more than a funding ceiling. However, it again pointed to the $150-million reserve fund available to the Secretary if a technological breakthrough in a promising program indicates that such funds are required.

Army RDT&E was cut by $106.8 million, leaving $1.363 billion. The House also dashed any hopes of DOD that a reserve fund of $59.6 million left over from *Advent*, which was transferred to the Defense Communications Agency when *Advent* was cancelled, could be used by DCA for communications satellites this year. This amount was deducted from the '64 budget, and the reserve funds assigned to the Army.

Thus, DCA got only $70 million and a warning that Congress feels that it would be unwise to develop a random-orbit satellite if a synchronous orbit system can be achieved shortly afterward.

A $5-million cut from the *Lance* missile's classified request was made on the basis that if the Army directed the contractor (Ling-Temco-Vought) to produce the missile in Warren, Mich., it should not exceed the amount for which it could be developed in Dallas.

Navy RDT&E was slashed $47.2 million to total $1.526 billion, the entire reduction resulting from the 3% across-the-board cut.

Air Force programs were cut by $206 million, bringing that amount to $3.416 billion. The biggest cut was $100 million for the *MMRBM* program. Cuts in the military astronautics section will leave slightly less than $1.2 billion, with *Dyna-Soar* the only manned space program. ■

An M/R exclusive . . .

Gun Launches Show A-ICBM Potential

U.S.-Canadian project directed by McGill University uses 16-in. naval gun, points to cheaper satellite firings

GUN-LAUNCHED MISSILES have been fired successfully to altitudes of nearly 65 miles in the early stages of Project HARP, a just-disclosed joint U.S.-Canadian project with possible eventual anti-satellite and A-ICBM applications.

The tests also indicate the possibility that small nations may be able to put satellites in orbit very inexpensively.

A dozen inert missiles have been fired from a rebored U.S. 16-in. naval gun in tests held in Barbados, British West Indies, last month and last January.

Firing of more advanced missiles with boost motors is scheduled in a series of tests due to start later this month on the Caribbean down-range island. These are expected to reach 300-mile altitudes.

- **Canadian direction**—Project HARP (High Altitude Research Project) is being directed by McGill University of Montreal under funding from the U.S. Army Research Office. Project scientist is Dr. Charles Bull, professor of engineering sciences at the Canadian school.

Ballistics Research Laboratory of the Army's Aberdeen Proving Ground has been collaborating with McGill on the project. Funding to date has totaled some $500,000.

The most recent test series concluded June 19 with a successful launch to a 340,000-ft. altitude of the Martlet 2A, a 185-lb. missile 50 in. in length with a 5-in. diameter. (Martlet is the bird on the McGill University crest.)

Martlet I was a 300-lb. missile with an 8-in. diameter and the next vehicle scheduled for testing in the series is the advanced Martlet 3A.

This is a 165-lb. active missile which will be propelled by an Aerojet-General 6-in. rocket motor using an extruded double based propellant bonded to the case. It is expected to boost a 50-lb. payload to 300 miles. Propellant, which already has been tested under high G loadings in a series of mortar firings, is 50% nitrocellulose, 40% nitroglycerin and 10% binder. Specific impulse is 280-300 with a chamber pressure of 1200 psi.

- **Grueling g-load**—The rocket motor as well as the payload and electronic gear aboard the Martlet 3A will have to withstand 12,000 Gs in firings from the naval gun. Solid-state telemetry developed by McGill for use in the earlier firings has withstood the high loadings successfully, McGill scientists report.

"There are no major problems in instrumentation," Dr. Bull asserts.

The rocket motor has been tested to a simulated 15,000 Gs in the mortar firings. After launch from the gun, the missile will coast to an altitude of 50,000 ft. before firing of the first-stage motor. Muzzle velocity from the gun is 5400 ft./sec.

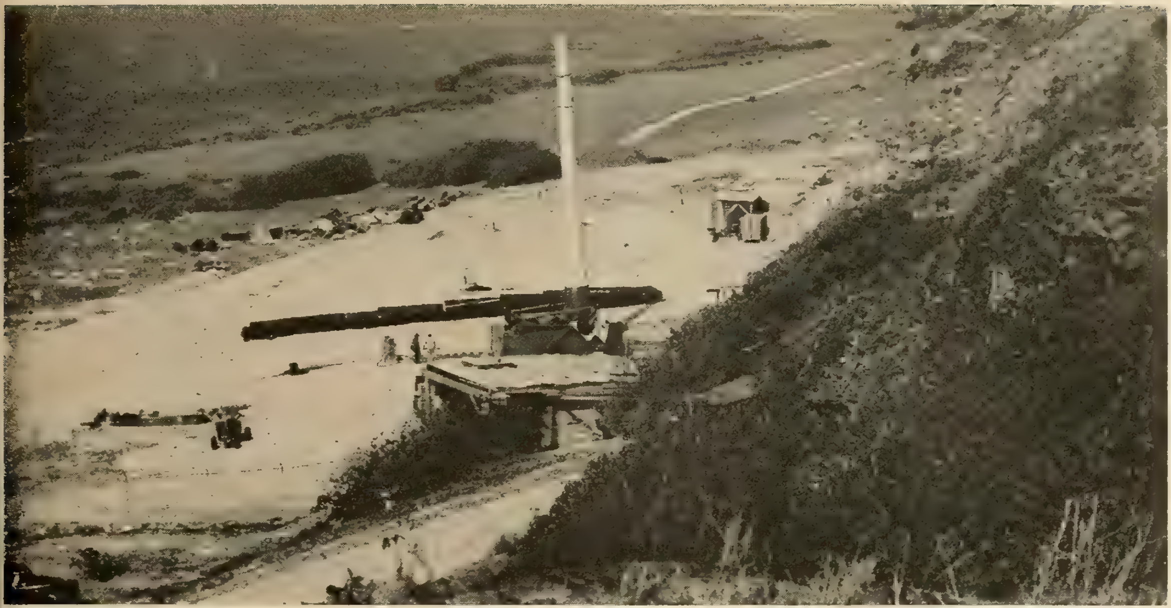
In addition to hardware already developed, McGill has in the study phase a two-stage Martlet 4 vehicle with orbital capability. This could place a 50-lb. payload in orbit for an estimated $50,000, according to project officials.

Martlet 4 would be a 3,000-lb. vehicle some 14-ft. long with a 16.4-in. diameter. (The naval gun in use has been drilled out to a smooth bore 16.4-in. The smaller missiles employ wooden sabots to guide them down the barrel.) Martlet 4 would be equipped with flip-out fins and a solid-state guidance system. Muzzle exit velocity would be 3000 ft./sec.

In addition to the obvious anti-satellite and A-ICBM potential of a vehicle with such a high velocity, Project HARP also offers the possibility that smaller nations without large booster facilities will be able to orbit satellites of their own with the inexpensive gun-launch technique.

- **Economic appeal**—Officials on the program refused to discuss possible military applications but emphasized the benefits of the comparatively cheap launch method. One said the

EXIT OF MARTLET 2A from muzzle of gun in June 19 firing to record 340,000 ft. Note sabots falling away. Gun is elevated to 80 degrees on this shot. Missile landed 100 miles distant. With barrel elevated to 87½ degrees on earlier shot, vehicle dropped only 10 miles from launch site.



REBORED NAVAL GUN from battleship USS Washington is shown in Barbados installation. Standard powder bag is used for charge, filled with a British WM propellant. Gun barrel is 50 ft. from trunnion to muzzle, can be raised and fired in 120 sec.

technique can be employed to send a probe to an altitude of 150 miles with a payload of 50 lbs. for only $1,500, far cheaper than current probes.

The joint U.S.-Canadian project is not the first or only program to test gun-launching of missiles but has carried the project further than any others and with a larger gun. The U.S. Army now is modifying a rocketsonde for gun-launching at White Sands Proving Grounds and Aberdeen itself also has carried out a number of experiments with a 5-in. gun.

Tests to be undertaken in the current series, which will see more than 30 missiles fired by year's end, include sodium vapor tracking, wind shear studies with smoke release, chemi-luminescence studies with nitric oxide release, re-entry studies with back-firing of shaped charges and telemetry measurement of ion density and temperatures at altitude, in addition to engineering development studies.

In addition to support from the Army, the program also has been followed with close interest by the U.S. Air Force. Squadron Leader John P. Jepson, Royal Air Force exchange officer who heads the High Altitude Test Vehicle Directorate at Eglin AFB, Florida, was an observer at the Project HARP test series just concluded.

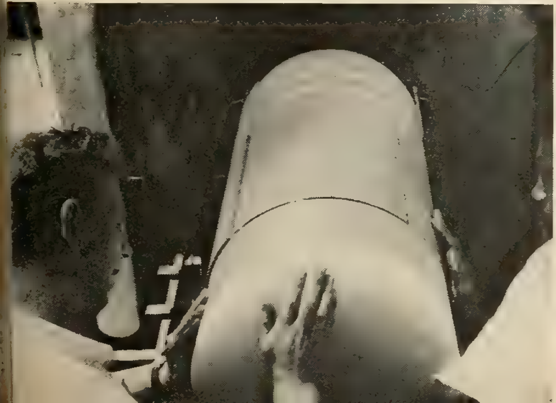
"I am very enthusiastic about this program," he stated. "It is a new technique in probe hardware and very much the coming thing in probe operations."

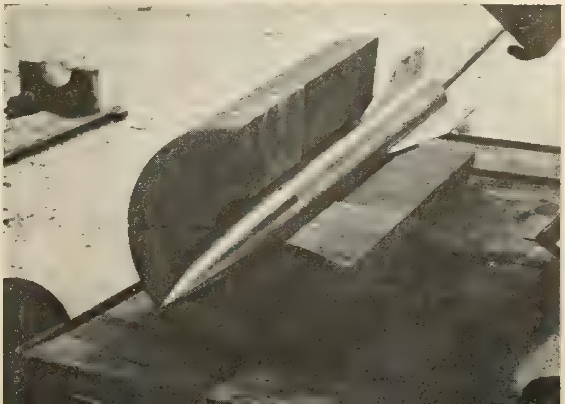
The high velocity of the missiles virtually eliminates any problems with low altitude winds and permits extremely close prediction of the impact point.

● **Accurate in tests**—With the gun elevated to 87½ degrees on one shot in the series, the missile landed only 10 miles offshore from the launch site—and 70 ft. from the predicted impact point. The June 19 shot to 340,000 ft. altitude, with a muzzle elevation of 80 degrees, impacted 100 miles away.

For use in an anti-satellite or terminal A-ICBM role, the guns employed could be swivel-mounted and linked to tracking radars. Development of a solid-state guidance system would be necessary but the fact that McGill already has developed successful solid-state telemetry for the project puts it a good way along on guidance development. ■

LEFT: *Roy Kelley (left), resident manager at Barbados, and local technician load projectile into McGill University big gun. Kelley grips polyethylene obturator which seals in gases. Large metallic section shown is aluminum pusher plate.* **RIGHT:** *Martlet II test vehicle with wooden sabots employed in Barbados high-altitude research project. Finned missile is made of heat-treated 4340 steel. Wooden sabots guide missile down barrel, fall away after exit from muzzle.*





Status report shows . . .

SMS Flight Program Funding Now Expected No Earlier Than Fiscal '66

Tepper says civilian weather program should meet Defense needs; first Nimbus shot slips; interim system studied

FUNDING OF A *Synchronous Meteorological Satellite* (*SMS*) flight program will not be included in NASA's budget until Fiscal 1966.

Dr. Morris Tepper, director of meteorological systems, told MISSILES AND ROCKETS that the program will push the yearly budget for weather satellites to $80 or $90 million, compared to the Fiscal '64 request of $70 million.

Noting that *SMS* is still not an approved NASA program, Tepper said it is possible small hardware funding may be requested in Fiscal '65. The earliest that flight program funding can be expected, he continued, is Fiscal 1966.

- **Design decision pending**—Tepper said firm decisions on spacecraft design and funding will not be made until the current extensive *SMS* study program is completed. Based on experience with *Tiros* and *Nimbus*, he estimated each of the synchronous satellites will cost "as much as $40 million."

In a status report on the weather satellite program, Tepper also said:

—Based on what he knows of military requirements, NASA's current program can fulfill any DOD needs for a weather satellite system. He added that he is not aware of any DOD plans for a separate system.

—The first flight of the advanced 700-lb. *Nimbus* satellite will be made this winter. Originally scheduled for the last quarter of this year, the launch will slip into early 1964, the new timetable indicates.

—An interim weather satellite system using a *Nimbus* and two "cartwheel" *Tiros* spacecraft is now being studied.

—The last *Tiros* in the R&D program will be launched to a synchronous 22,300-mi. altitude in an experimental effort to provide data for *SMS*.

- **SMS approach**—Tepper said NASA's approach to the *SMS* program is different from its treatment of the *Tiros* and *Nimbus* programs. The main emphasis now, he said, is on a lengthy study of engineering problems associated with its development.

"After we focus our attention on these, we can lay out our program and have a more realistic flight schedule."

He pointed out that study contracts have been awarded to Republic Aviation Corp. for an overall study of *SMS* requirements, to RCA for a study as to how *Tiros* technology can be applied to the program, and to Hughes Aircraft to study how the *Syncom* communications satellite development may be useful.

"I imagine that before the end of 1963 we will have a pretty good handle on the studies," he said.

He estimated that after the industry studies are completed, NASA would spend another 18 months studying the *SMS* system. With an additional 1 months required to develop the satellite a flight program is still three to fou years away.

He also predicted that no major system study contracts would be awarde to industry in the near future. He adde that it was difficult to predict what stud requirements would be in the subsystem area.

- **Nimbus difficulties**—Tepper admitted that the *Nimbus* program ha run into many problems, mainly because it is "a tremendous giant step i weather satellite development."

Problem areas included the contr system, power supplies, paddles and associated electronics and cameras.

The sensory ring for the spacecra is now being assembled. This will followed by testing of the spacecra integration.

If no further problems develo Tepper said, the first flight of the sate lite will be made this winter, some months later than the original sche ule.

NASA plans to fund four R& *Nimbus* spacecraft. The Weather B reau program will add five more for total of nine.

The first two satellites will launched within six months of ea other, but later flights will be separat by about one year.

F-1 Engine Problem 'Under Control'

A TOP NASA official declares that the combustion instability problem of the F-1 engine is now "under control."

A. O. Tishler, director of the space agency's liquid propulsion program, says installation of a mechanical isolator has separated oscillations in the engine pump from oscillations in the fuel system.

"Since that time the engine has been tested under the most severe conditions and there has been no evidence of combustion instability," Tishler said.

He added that before installation of the isolator, the instability had cropped up only twice in five months.

Tishler predicted that the F-1 liquid oxygen/kerosene engine—which will power the first stage of the *Advanced Saturn*—will pass its preliminary Flight Rating Test (PFRT) this year. This was originally scheduled for mid-1963.

NASA has also ordered Rocketdyne, prime contractor for the engine, to conduct an experimental program on the engine before it is fully qualified in 1966.

The program, designed to clear up any bugs including any further incidences of instability, could last several years of a minimum of six to eight months.

Destination: EARTH

fter a final, over-the-shoulder lance at the craggy lunar scene, oon explorers will apply them- elves to the new task at hand—etting back home. How will the inar declination at time of lift-off e interrelated with earth landing ite latitude, time of flight and nding range from re-entry at γ= -6° to touchdown?

Curves Provide Key

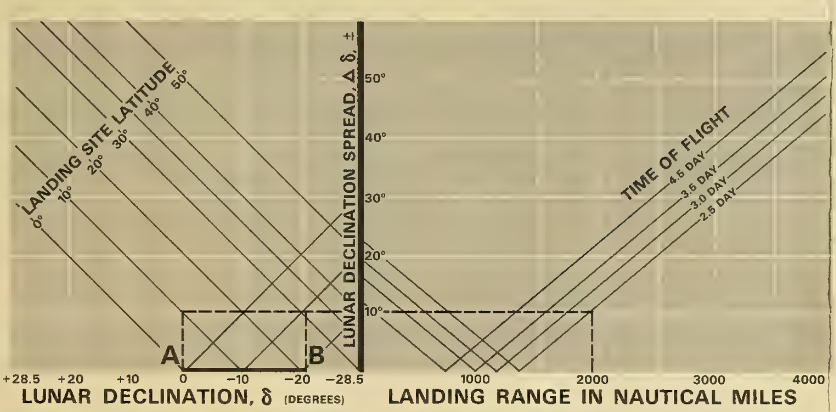
he curves at upper right provide ie key. Window AB describes the nge of lunar declinations, from 0.5° to −20.5°, acceptable for turning to an earth landing site a latitude of +10°, for a 2.5 day me of flight with a landing range 2000 n.mi. from re-entry at γ= 6° to touchdown. The schematic lustration shows the trajectory ane for a lunar declination of 10°. As lunar declination varies rough the acceptable range own in the curves, the trajectory ane will rotate around the radius om earth center to landing site.

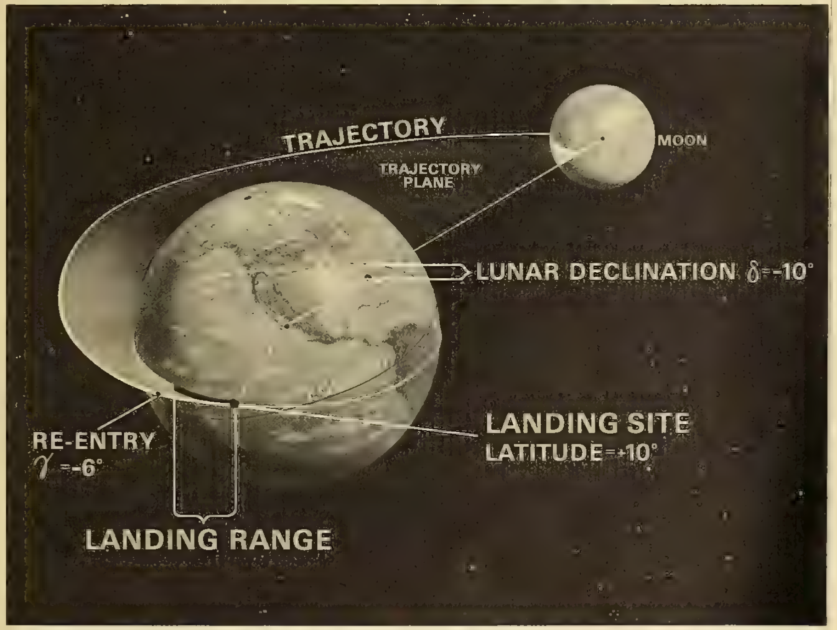
Variety of Opportunities

t Astronautics, we are deeply in- lved with a great variety of ace-oriented activities. These in- ude the design and development boosters and vehicles to accom- ish far-ranging missions as well the analysis of the paths they ll follow. We're developing the ecise electronic systems that will ide, track and communicate with e men and machines. Our efforts ng many aerospace frontiers are ating a number of opportunities engineers and scientists with ceptional abilities. If your in- ests and experience qualify you fill one of these positions in vanced areas of activity, we urge ır inquiry.

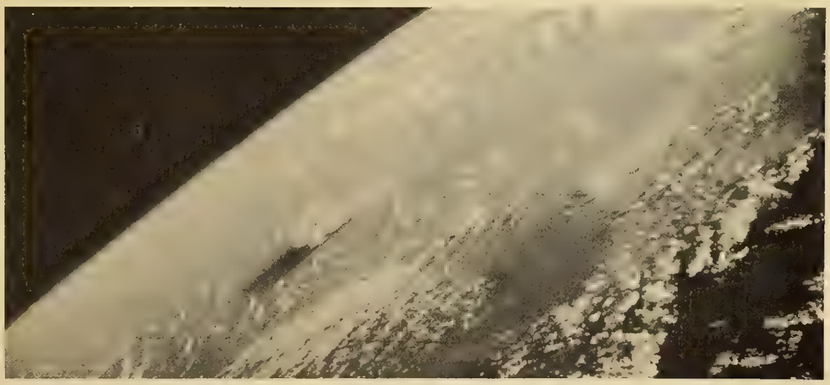
Details for ngineers and Scientists

u will find details of current po- ions on the next page. Your ly, which will be held in com- te confidence, can be made on attached Professional Place- nt Inquiry form or by writing R. M. Smith, Chief of Profes- nal Placement and Personnel, il Zone 130-90, General Dy- nics|Astronautics, 5840 Kearny la Road, San Diego 12, Calif.





LUNAR LIFT OFF AT δ = −10° *Heading for an earth landing site latitude of +10°, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from γ= −6° to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

GD

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ENERAL DYNAMICS | ASTRONAUTICS

A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTISTS

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following area:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and nonlinear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

GUIDANCE and CONTROL SYSTEMS

Requirements exist in three general areas: (1) analytical area for those with experience in establishing guidance and flight control system requirements and analysis of system performance; (2) activities involving detail design and development of the autopilot, programming devices and passive tracking equipment with additional responsibility for design of associated test equipment; (3) design liaison group, responsible for assuring accuracy and reliability of the guidance system by monitor of the system-manufacturing sub-contractor, and activities to assure that delivered ground support equipment and airborne systems mate with the missile and its checkout complex.

BS degree in EE and/or physics, plus 3 to 5 years of direct experience with navigation and guidance systems design or test, are required.

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability, or both. Tasks involve technique development in the following:

SYSTEMS: User-operations analysis, reliable systems design, systems reliability models, cost-effectiveness evaluation, man-machine systems analysis;

COMPONENTS: Reliable hardware design, hardware analytic evaluation, component evaluation, parts and materials selection, specification criteria, supplier programs and evaluation.

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

FLIGHT TEST ENGINEERING

BS, ME, EE or physics degree is required for electronic systems testing and checkout of the Centaur launch complex and space vehicle. Up to 2 years of experience in the following areas is required: guidance, flight control, telemetry, RF systems, propulsion, pneumatics, hydraulics and mono-propellants. Positions are available in San Diego and at AMR, Cape Canaveral.

Openings also exist for graduate engineers in the following:

INERTIAL GUIDANCE, ADVANCED ELECTRONIC SYSTEMS, PROPULSION ANALYSIS, MECHANICAL DESIGN, QUALITY CONTROL, STANDARDS & CALIBRATION LABORATORIES, EMI AND RFI CONTROL, FAILURE ANALYSIS AND TEST EQUIPMENT DESIGN.

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GENERAL DYNAMICS | ASTRONAUTIC

ASTROLOG

Current status of U. S. missile and space programs

Missiles

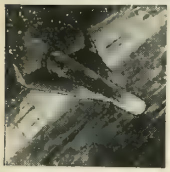
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; weight—500 lbs.; solid; HE depth charge; free-flight rocket; range 900 yds.	Operational; deployed on destroyers and cruisers
★**ASROC** (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid; nuclear or conventional warhead, range between 1800 yds. and 8 miles; weight: 1000 lbs.; unguided	Operational on DE, DD, DLG, & heavy cruisers. Advanced ASROC being developed; one "live" weapon fired in Pacific nuclear tests
ASTOR (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional; range, about 11 n. m.; solid	Development; to be deployed on hunter-killer submarines
★**ATLAS** (Air Force)	STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series inertial guidance; ATLAS "D" radio inertial	13 squadrons operational at 11 bases; total no. of missiles: 129; phaseout to begin soon; ATLAS Standard Launch Vehicle being developed for AF space programs; 5-engine model proposed
BOMARC (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000	Five bases operational in northeastern U.S.; production completed; costs $20 million per year to operate system
★**BOMARC B** (Air Force)	Boeing, prime; Gen. Precision Aerospace/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 n. m. range; nuclear	First base operational May, 1961; two more planned; production completed
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol/Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and one pre-packaged liquid motor; nuclear-tipped	Deployed with Atlantic and Pacific Fleets; operational with Air Force units; new training version under development, as TGAM-83 replacement
CORPORAL (Army)	Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion	Surface-to-surface; 75 n. m. range; liquid; nuclear; pre-set & command guidance	Deployed in Europe. SERGEANT replacing CORPORAL
DAVY CROCKETT M-388 (Army)	In-house project directed by Army Weapons Command at Rock Island, Ill.	Surface to surface; solid; bazooka-launched; sub-kiloton nuclear warhead; two launchers: vehicle-mounted or carried by two men	Operational in Europe; $13 million provided in FY '64 budget; 20 per division; seen as defensive rather than offensive weapon to prevent overrun of Europe
ENTAC (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; solid; shaped charge HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
★**FABMDS** (AADS-70) (Army)	Hughes, Raytheon, RCA—feasibility studies	Field army ballistic missile defense system, mobile	Expected to be operational in 1970's
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion; Lockheed Propulsion, GAR-9 propulsion	Air-to-air; 5 n. mi. range; supersonic; solid; conventional; 1, 1D and 3A, active radar homing guidance; 2, 2A, 2B and 4A, IR homing; GAR-11 model has nuclear warhead and hybrid IR radar homing	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under minimum effort development
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 6-mile range; nuclear; solid rocket; supersonic; proximity fuzing	Operational on F-101B & F-106; improved version cancelled
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; 100-45,000 ft. ceiling; launch wt., 1275 lbs.; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); bought by Sweden and Israel; advanced HAWK being funded at $25.9 million for R&D as antimissile weapon

★ Indicates changes since May 1963 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN M-50 (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5900 lbs.; ADVANCED HONEST JOHN also being developed	Operational; deployed in Europe; to be replaced by LANCE
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 2+; turbojet nuclear B version in production, ceiling in excess of 50,000 ft.	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400 to compensate for SKYBOLT cancellation
JUPITER (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; range over 1500 mi.; guidance; all-inertial	Being withdrawn from operation; replaced by POLARIS; future of missiles being studied
LACROSSE (Army)	Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion	Surface-to-surface; mobile; command guidance; 20-mile range; solid; nuclear	Operational; three units in Europe; eight activated; to be replaced by LANCE
★**LANCE** (Army) (Formerly designated MISSILE B)	Chance Vought Div., Ling-Temco-Vought, prime; Systron-Donner, AUTOMET guidance	A highly mobile general-purpose missile; range 3-30 miles; Automet guidance; one missile per launcher; nuclear and conventional warhead; pre-packaged storable propellants	Large-scale development; eventually will replace HONEST JOHN and LACROSSE; division support weapon; to use multi-system test equipment
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable; may be replaced by LANCE
M72 (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; range 500 yd.; earlier called LAW	Operational
MACE (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid; nuclear; B model: 1200-mile range; inertial guidance	Five MACE-A and one MACE-B squadron deployed in Europe; two MACE-B squadrons on Okinawa in hard sites
MATADOR (Air Force)	Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft.	Being turned over to West Germans; also deployed in Korea and on Taiwan
MAULER (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; deHavilland, IR acquisition; Raytheon, radar; Burroughs, computer; FMC, vehicle	Surface-to-air; IR acquisition; solid; weight, 120 lbs.; highly mobile antiaircraft and antimissile missile; tracked vehicle; 9 per launcher rack	Development; NATO may buy; Navy planning SEA MAULER; to use multi-system test equipment; FY '64 request is $83.3 million; usable against short-range tactical missiles
MOBILE MEDIUM-RANGE BALLISTIC MISSILE (Air Force)	Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos & Sperry Rand, re-entry system; Thiokol, propulsion; Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania, command and control; General Precision, guidance	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Continued development; no decision yet on production or deployment
MINUTEMAN (Air Force)	STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules third stage; Avco, re-entry vehicle	2nd-generation ICBM; solid; deployed in hardened and dispersed silos; 32 sec. reaction time; nuclear; 3 stages; range: over 5000 miles; guidance, all-inertial; target selected in seconds; advanced MINUTEMAN with greater range-payload and new re-entry vehicle under development	Development; 100 now operational at Malmstrom, Mont.; later at Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D., Grand Forks, N. D.; 950 missiles through FY '64; eventual force size may be 1300; advanced version to be fired from mobile command posts; expected operational 1965-66
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; ceiling, in excess of 150,000 ft.; solid; command guidance; Mach 3+; nuclear or conventional; antiaircraft, tactical missiles; weight, 10,000 lbs.	Over 80 batteries deployed in U.S.; over 10 N-H batteries deployed overseas. To be equipped with HIPAR, a high power acquisition radar, and anti-tactical-ballistic-missile capabilities
NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Antimissile missile; 3-stage; 200-mile range; solid; nuclear; command guidance; weight, 22,800 lbs.; length, 48 ft.; diameter, 36 in.; fin span, 10 ft.	Downgraded in favor of NIKE-X; continued development planned; funded for $89 million in FY '64; several successful intercepts
★**NIKE-X** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin-Marietta, SPRINT missile prime; Hercules Powder Co., and Lockheed Propulsion Co., SPRINT propulsion	Most advanced portion of NIKE-ZEUS concept; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR)	Engineering development; funded for $246 million on accelerated development schedule, but deployment still deferred; more effective than NIKE-ZEUS
PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; inertial guidance; approx. 400 n. mile range; nuclear; transported on FMC XM474 tracked vehicle; to replace REDSTONE	Flight test program, including shots from Utah to New Mexico, nearly complete; first tactical equipment delivered to troops in December, 1962; West Germany buying

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
PHOENIX (Navy)	Hughes Aircraft Co.	Air-to-air missile for use with the TFX fighter aircraft	Development; HAC has $12.2-million contract
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT/Hughes, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programing	Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 aboard first five submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 6-17; A-3 (2500 n.-mi.) aboard 18th and subsequent subs; all subs to get A-3 eventually; Total authorized POLARIS submarine program: 41	Nine subs each with 16 missiles operational; A-2 operational; A-3 in 1964; 14 A-3 flight tests have been conducted; five fully successful; deployed in Atlantic and Mediterranean; Pacific servicing facilities being built; British to buy missiles from U.S.
QUAIL (Air Force)	McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Thompson Ramo Wooldridge, ECM equipment	ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
REDEYE (Army)	GD/Pomona, prime; Philco, IR seeker; Atlantic Research, propulsion	Surface-to-air; 4-foot, 22-lb. bazooka-type; IR homing guidance; solid; conventional; length, 44 in.; diameter, 2.75 in.	Development; no procurement funds in FY '64 budget due to development problems resulting in two-year slippage
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; inertial guidance; nuclear	Deployed in Europe; being replaced by PERSHING
REGULUS I SSM-N-8 (Navy)	Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear	Deployed aboard 2 cruisers; phaseout of 5 Regulus subs to start this year; KDU-1: drone version; missiles retrofitted with airborne guidance
SERGEANT (Army)	Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; over 75 n. mi. range; nuclear; inertial guidance uses drag brakes; 10,000 lbs.	Production; major procurement to be completed during FY '63; replacing CORPORAL; West Germany buying and has activated one battalion
SHILLELAGH (Army)	Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance	Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; testing at White Sands; to use multi-system test equipment; engineering development stage begins in FY '64; to be installed on Gen. Sheridan assault vehicle
SHRIKE (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly ARM	Development; first production buy in FY '63; AF plans to buy it during FY '64
SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; 1-C models: switchable IR and radar-guided warheads; improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version started in 1962; NATO-built version now under test
SLAM (Air Force)	Ling-Temco-Vought, vehicles; Atomics International Div., NAA/Lawrence Radiation Labs, reactor; Marquardt, propulsion	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph	Propulsion system being developed under project PLUTO; feasibility proven by TORY reactor tests; DOD decision whether to continue program due this month
SPARROW III AAM-N-6A (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; production begun on advanced version (SPARROW III B) prime armament for F4H-1 and F3H-2 interceptor; SPARROW III and III A in use
★**SPRINT** (Army)	Martin-Orlando, prime; Hercules Powder and Lockheed Propulsion Co., propulsion	High-acceleration missile for low-altitude interception of ballistic missiles; to be part of the missile mix in a NIKE-X battery	Development; studies submitted by Douglas, Martin and North American
★**SUBROC** (Navy)	Goodyear, prime; Gen. Precision/Aerospace, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack subs of Thresher class; reportedly entire system was tested in recent nuclear tests
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units and Army helicopters
TALOS (Navy)	Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance	Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance	Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, nuclear-powered cruiser, has advanced TALOS
TARTAR (Navy)	Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Ship-to-air; 10-mile range; Mach 2; beam-riding guidance; solid dual-thrust motor; conventional	Operational; installed aboard 15 guided missile destroyers and cruisers equipped with TALOS
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
TERRIER/ADVANCED TERRIER (Navy)	Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; ABL, propulsion	Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional; 2 advanced versions operational	Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle; Thiokol, solid rockets for added thrust	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear; guidance, all-inertial; used extensively as space booster	Phaseout; 15 missiles to be converted by Douglas for space boosters; some vehicles "souped up" by adding solid rockets for DISCOVERER program
TITAN (Air Force)	STL, systems engineering & technical direction; Martin, prime; Bell/Sperry, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	ICBM; 5000-mile range, LOX/RP-1 fueled; 90 ft. long; 2 stages	Operational; 54 missiles at 5 bases
★**TITAN II** (Air Force)	STL, system engineering and technical direction; Martin, prime; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle	ICBM; over 5000-mile range; N_2O_4 & Aerozine-50 storable fuels; 115 ft. long; 2 stages; greatest payload & range of any U.S. ICBM; basic core vehicle for TITAN III	One squadron operational at Davis-Monthan AFB; some trouble experienced with second stage and with vibration; to be used with GEMINI program as booster; overall performance high
TOW (Army)	Hughes, prime	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC
TYPHON (Navy)	Bendix, GD/Pomona, missile and missile electronics; Westinghouse, weapons direction system and radar; McDonnell, propulsion	Medium and long range seagoing antiaircraft and antimissile missiles with offensive capability against surface ships and shore targets	Development; successor for TALOS, TARTAR and TERRIER. System is encountering development problems and deployment will await extensive testing
★**WALLEYE** (Navy)	NOTS-China Lake	Air-to-surface 1000-lb. glide bomb with homing guidance, no propulsion; powerful conventional warhead	Development; Navy says it will be the "most accurate and effective air-to-surface conventional weapon ever developed anywhere."
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	5-inch, air-to-surface; solid; unguided; 5 n.-mi. range; conventional	Operational; designed for use on jet fighter and attack aircraft



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ANNA (NASA)	Bureau of Naval Weapons/Applied Physics Lab, prime; AF Cambridge Research Laboratories/Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter	Geodetic satellite; 600-mi. orbit; 36-in. aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by DELTA	Development; first launch failed May 10; second launch successful in November. Program now under NASA management. NASA to launch one satellite per year beginning in 1964
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; Grumman Lunar Excursion Module (LEM); MIT, guidance development; Collins Radio, telecommunications; Minneapolis-Honeywell, stabilization & control; AiResearch, environmental control; Radioplane, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN C-1B for earth orbits; Advanced SATURN (C-5) for lunar rendezvous; 3-modular spacecraft: command module, 5 tons; service module, 23 tons; lunar excursion vehicle, 15 tons; total weight: 85,000 lbs.	Earth orbital shots scheduled 1964-65; lunar orbits 1967; lunar landing 1968
ARENTS (ARPA)	GD/Astronautics, prime	Series of three satellites to investigate space environment of 22,000 mi. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload; program re-evaluated due to CENTAUR delay
AEROSPACE PLANE (AF-NASA)	No contracts announced	Manned, hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, LH_2-LOX rocket	Joint NASA-AF research program approved. NASA funding $4 million in FY '64
ASSET (Air Force)	McDonnell Aircraft Corp., prime; Minneapolis-Honeywell, guidance	Aerothermodynamic elastic Structural Systems Environmental Tests for various materials combinations during re-entry; two versions planned, 1100 lbs. (4) and 1200 lbs. (2). Strongly resembles X-20. Length. 68.7 in.; span: 58.9 in.	Development; six vehicles to be built & launched with THOR and THOR-DELTA boosters at AMR beginning this summer. Designed to obtain same general type of aerodynamic research information as X-20
BAMBI (ARPA)	Studies: GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost using space based platforms and interceptors	Feasibility still not proved; additional research under way
BIOS (NASA)	GE, Lockheed, Northrop, study contracts	Recoverable capsules with primates aboard; capable of orbital flights up to two weeks; Flights to begin 1964	Program under study. Selection of prime expected by third quarter 1963. NASA FY '64 budget request, $24 million

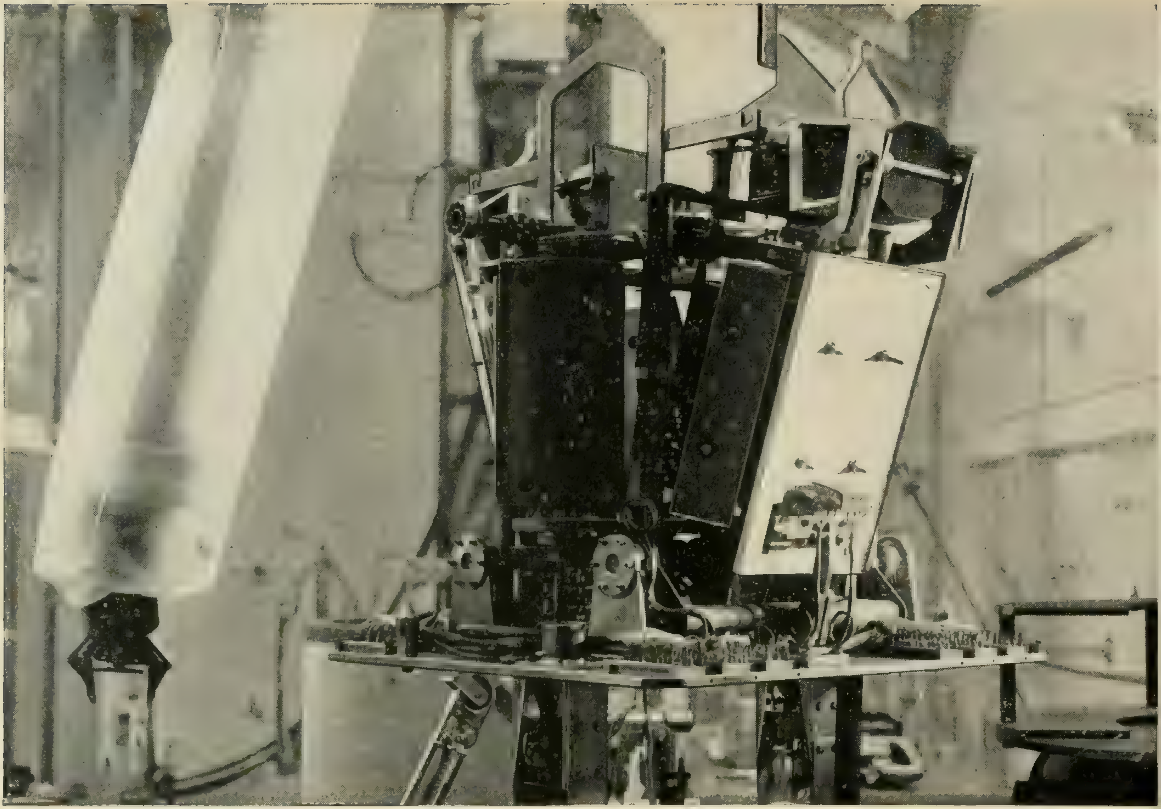
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE** (AF-DCA-Army)	GE, Philco-STL; program definition studies	Multiple-launch, active repeater ComSat; 24-36 satellites in 5000-12,000 naut. mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster	One of two systems resulting from re-oriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966; RFP's due this month
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR (X-20)** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sundstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; future doubtful; emphasis now on suborbital flight tests with orbital missions "possible" later
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful. Orbital launch from PMR planned late 1963
★**GEMINI** (NASA)	McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Westinghouse, rendezvous radar	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, early 1964. Manned and rendezvous flights, 1964-65; AF participation in program has been approved; this could add 4 to 6 more spacecraft to the program
INTERPLANETARY MONITORING PLATFORM (NASA)	Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit	125-lb. satellite launched into deep-space orbit with an apogee of 172,000 miles. It will measure radiation and solar flares in advance of Project APOLLO hazard. Launched by DELTA booster from AMR	Program calls for eight satellites. Launches will begin late 1963. Later flights will use a nuclear power unit as replacement for solar cells
★**LUNAR LOGISTICS VEHICLE** (NASA)	Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp.	Spacecraft to carry support payloads to the Moon. Two designs under study, LEM Truck and logistics spacecraft with 25,000-to-30,000-lb. payload	Program decision expected late 1963, with two-year delay expected in development; program would cost about $1 billion
★**MANNED ORBITING SPACE STATION**	Boeing and Douglas; NASA study contracts	Manned space station for testing components and techniques in the space environment. Design under study by NASA and AF	NASA and AF contending for program. Decision expected late 1963. NASA has requested bids on four study concepts. Small 4-6-man station will be built first. For flights in post-1966 period
MARINER (NASA)	JPL, prime	450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14; two Mars fly-by missions planned in 1964
★**MDS** (NASA)	Fairchild Stratos, prime	3400-lb. meteoroid detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit, 300 to 800 miles; booster SATURN 1	Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch scheduled for mid-1964; two will be orbited
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY made 22-orbit flight with L. Gordon Cooper on May 15. Program now completed
★**MIDAS, PROGRAM 239A** (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; re-oriented system now funded for total of $450 million; funding of $150 million for FY '63 now cut to $100 million for FY '64

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**NIMBUS** (NASA)	Goddard Space Flight Center prime; GE, integration and testing; RCA, videcon cameras	2nd-generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for early 1964; second, six months later; four R&D satellites, five Weather Bureau satellites planned
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3600-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, ATLAS-AGENA D	First flight scheduled in 1964; two more in 1965
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; nine other shots planned—five in '64 and four in '65
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; 10 more flights planned; advanced OSO studies by Ball Bros., Republic and STL
★**PIONEER** (NASA)	STL	120-lb. spin-stabilized solar probe; DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; 4 outrigger booms for stabilization; 5 experiments, 60-to-90-million-mi. communication capability	Seven launches in program; early 1965 launch schedule set; orbits range from .8 to 1.2 au for 6-mo. lifetime
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket; Northrop, serving as support contractor, will be named prime in 1964	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D RANGER VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; plans call for a total of 22; next launch, third quarter 1963
RELAY (NASA)	STL, project coordination and systems planning; RCA, prime	172-lb., spin-stabilized, wide-band, 700-3000-mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II November, 1963
SATELLITE INSPECTOR (SAINT) PROGRAM 706 (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system also capable of destroying hostile vehicles	R&D; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, based on a manned system using GEMINI capsule
★**SAMOS** (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300-mile circular polar orbit	Operational; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched in 1963 with Hughes and Lewis Center engines
SLOMAR (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded December, 1960; DOD studying concepts in connection with Manned Orbiting Development Station
SURVEYOR (NASA)	Hughes, prime; Martin, SNAP device	2100-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon-orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights early 1965; seven soft-landing vehicles planned; five lunar orbiters also scheduled
SYNCOM (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55-lbs.; capable of accommodating one full duplex radio telephone channel	First launch failed, Feb. 14, 1963 satellite believed to be in orbit but contact lost. Second launch planned mid-1963. 500-lb. advanced SYNCOM to be developed
SMS (Synchronous Meteorological Satellite) (NASA)	Republic, RCA, Hughes, study contracts	24-hour weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or CENTAUR	First flight 1966; No development funding in Fiscal '64 budget
★**TELSTAR** (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10, 1962, highly successful; second launch May 7, 1963, also successful
★**TIROS** (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3000-mi. apogee)	R&D; seven satellites launched; all successful. Seven more added to program (4 R&D NASA, 3 operational, Weather Bureau)

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TRANSIT (Navy)	Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; TRANSIT 5-A failed after achieving orbit in December; NASA also will use TRANSIT for civilian navigation satellite system
VELA-HOTEL (ARPA)	STL, prime; Los Alamos Scientific Lab/Aerospace, payload	12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; booster, ATLAS-AGENA	Initial launchings expected during this calendar year
VOYAGER (NASA)	Study contracts, Avco Corp. & GE	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface	Funds may be in FY '65 budget. Launches in 1968-70 period. Spacecraft of 6,000 lbs. to be launched by ADVANCED SATURN
X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000-mph flight at edge of space; each rocket engine develops 57,000 lbs. thrust; re-entry fights providing data for X-20	Powered flights in progress; unofficial records set: altitude (314,750 ft) and speed (4104 mph); X-15 will be used as trainer for X-20

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-lb. upper stage; all-inertial guidance; re-start capability	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable of orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date; next launch fall, 1963
DELTA (NASA)	Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3-stage vehicle; 430 lb. payload capability in 500-mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively; THOR missile comprises first stage	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational this year
LITTLE JOE II (NASA)	General Dynamics/Convair, prime	Solid-propelled vehicle with thrust of 800,000 lbs.; launch vehicle for APOLLO suborbital flights	First launch scheduled mid-1963; six vehicles ordered thus far
NOVA (NASA)	General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study. Further studies to be awarded	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st-stage thrust or nuclear upper stage)	Study to determine characteristics; operational target date post-1970 time period
ORION (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift over 1000 tons into orbit	Studies; AF FY '64 request for $9.8 million denied by DOD; R&D continuing with funds re-programmed from FY '63
ROVER (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: tests of KIWI, prototype of NERVA engine, under way	First ROVER flight test expected before end of decade
SATURN I (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 22,000 lbs. into 345-mi. orbit	Four flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages July-August, 1963
SATURN I-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 32,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle
SATURN V (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-1B: 5 F-1 engines; S-11: 5 J-2 engines; S-IVB: J-2 engine; 120-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1965; prime booster for APOLLO missions; may also be used to boost Orbiting Space Station
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 300-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 300 lbs.; NASA has ordered 23 more boosters
TITAN III (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick-reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight late '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 5 TITAN II core vehicles (A version), 12 full TITAN III's (C version); operational in 1965

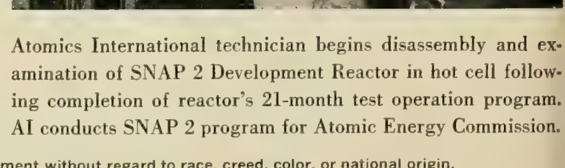


How you can help develop compact nuclear systems for space

Now, at Atomics International, you can take part in one of the most advanced nuclear projects of our time: the development of SNAP compact power systems for space. A.I., as a SNAP systems prime contractor for the Atomic Energy Commission, is responsible for the complete nuclear power system including development and integration of the reactor and shield, power conversion and space radiator subsystems. Complete flight systems are subjected to both nuclear and non-nuclear launch qualification. SNAP systems are designed to provide from 500 to several thousand watts of auxiliary power while operating unattended in space for a year. SNAP is one of many challenging nuclear projects underway at A.I.

Atomics International offers excellent growth opportunities for men of talent and imagination. Requirements include BS or MS in engineering or physics and strong analytical or experimental abilities in heat transfer, fluid mechanics, thermodynamics, mass transfer, nuclear analysis or component development. Ability to plan, direct and evaluate programs for development of space reactor components and systems essential. You are invited to inquire for further information.

Contact: Mr. H. G. Newton, Personnel Office,
Atomics International, 8900 DeSoto Avenue,
Canoga Park, California



Atomics International technician begins disassembly and examination of SNAP 2 Development Reactor in hot cell following completion of reactor's 21-month test operation program. AI conducts SNAP 2 program for Atomic Energy Commission.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL
Division of North American Aviation

Technical Countdown

ELECTRONICS

Solid Block Changes DC to Microwave

Microwave signals in the 0.5 to 6.5 gc range have been obtained by passing a current through a gallium-arsenide block. The phenomenon, observed by International Business Machine Corp. scientists, was reported at the recent IEEE Solid State Devices Research Conference in East Lansing, Mich., by J. B. Gunn. Outputs of up to 0.5 watt at 1 gc were obtained, he said. Dc-to-ac power conversion efficiency was less than 2%. Performed at room temperature, tests so far have involved only pulsed operation, but continuous operation and higher power are expected soon, Gunn said.

Efficient SNAP-13 Power Conditioner Developed

Martin-Baltimore engineers have developed what may be the first thermionic nuclear power conditioner. Actually a dc-to-dc converter, the device will be employed with the Martin-developed SNAP-13 nuclear generator to maintain constant voltage. Step-up from 1 volt to a steady 28-volt output is attainable. Built for the Atomic Energy Commission, the new conditioner achieves a 70% efficiency now and designers claim this soon will be raised to 80%. The 4-lb., 12-watt SNAP-13 development program is funded by the AEC to prove feasibility of using a radioisotopic heat source for practical thermionic conversion.

GE Awards Major ComSat Study to Motorola

Under a recently awarded two-month contract, Motorola's Military Electronics Division in Scottsdale, Ariz., will provide General Electric with detailed design specifications for a random orbit medium altitude communications satellite. The contract, valued at $250,000, was awarded by GE's Valley Forge Space Technology Center, one of two competitors striving for the ultimate military ComSat system.

AFMTC IGS Centrifuge Under Construction

The new 260-in. radius centrifuge being built by Genisco, Inc., for the Air Force Missile Development Center at Holloman AFB, is touted by AFMDC engineers as unique for calibration, testing and evaluation of inertial guidance systems and components. It reportedly will provide unperturbed centrifugal accelerations up to 100 g. Driven by a 450-hp motor, the centrifuge will include an aluminum revolving enclosure to assure circulation of air with the rotating arm. The facility is due for completion by next February.

Arnold To Get New Multi-Channel Telemetry

A data-transmission system capable of monitoring up to 3,000 separate sensors with an error rate less than 2% has been developed by Electro-Optical Systems, Inc. The Pulse Amplitude Modulation/Frequency Modulation telemetry system was built under a $133,000 contract for the Air Force's Arnold Engineering Development Center. It will be used, said EOS, for investigating space-chamber data-transmission problems. The system will progressively sample and transmit 3,000 separate input signals. Multi-sensor outputs from the test vehicle are processed first through solid-state multiplex equipment.

Eurospace Outlines Space Plans

Details of a proposed space program through 1971 disclosed at the recent Paris Air Show by Eurospace, the non-profit association comprised of 130 leading European manufacturers, called for an estimated first four-year total expenditure of from $600 to 735 million. Long-range plans included a 12-vehicle, 7,600-n. mi. altitude communications satellite system. First launch into equatorial orbit would be in 1968 using an *ELDO-A* boost vehicle. Total estimated eight-year system cost was projected at $542 million. Also proposed was a synchronous-orbit comsat system, using *ELDO-A* or *B* launch vehicles, requiring an eight-year estimated cost of $249 million. First four-year budget for R&D in both systems is $56 million. The present tariff of $2.10 per minute would be reduced to from $0.98-1.54 per minute depending on system operating life, said Eurospace.

OPTICS

Kollmorgen Optical Sights Raised

Directors of Kollmorgen Corp. have set their sights on cornering 30-35% of the U.S. precision optical-alignment instrument market within five years. A market analysis presented by company officers estimated the total optical alignment market sales for 1963 at $8.3 million, up from $6.3 million in 1962. Officers estimated the market, mostly alignment telescopes and autocollimators, would grow to $12 million annually within a few years. They pointed out that about 57% of current U.S. buys in this area are from foreign manufacturers, including 70% of the autocollimators and 30% of the telescopes.

PROPULSION

Monocompound Engine Successfully Tested

A successful 30-second test firing of its new monocompound rocket engine has been achieved by Astrosystems International, Inc., in Caldwell, N.J. The engine is being developed under contract with the U.S. Navy for eventual use in a supersonic drone. During last week's first full-scale test firing, the engine achieved full rated thrust and performance in accordance with scheduled requirements. Although details are sparse, the monocompound engine has been described by the company as "a radically new concept in liquid rocket engines."

ADVANCED MATERIALS

Leaded Building Materials Tested

The addition of thin lead sheets (0.006-0.114 in.) to conventional interior-wall material provides an increase in average sound isolation of from 5 to 7 db. Tests were conducted by Lewis S. Goodfriend & Associates, Little Falls, N.J., with standard materials including masonite, cement-asbestos board, steel, aluminum, and even concrete blocks. Accoustical isolation also proved effective at lower frequencies (0.5-2 kc), which more readily penetrate such materials without the lead sheathing.

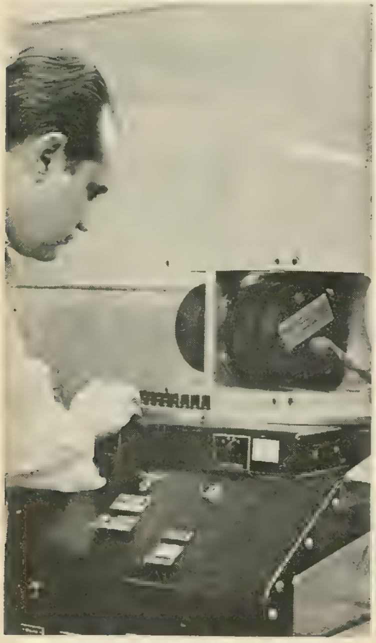
Agena-D Satellites Will Test Nortronics Attitude-Stabilization Gyro

Long advocated by NASA, M.I.T., lightweight control moment system requires only 20 watts of power; expected to operate 20,000 hours

by Charles D. LaFond

CONTROL MOMENT GYROS capable of directly effecting space-vehicle attitude stabilization may be flight tested late this year on several Air Force *Agena-D* series orbiting satellites.

Developed by Nortronics Div., Northrop Corp. for Lockheed Missiles and Space Co., the large-torque gyros (two per system) will be fixed to the craft to provide three-axis spatial control.



NORTRONICS CMG-II Control Moment Gyro will be used to implement spacecraft stabilization by gyroscopic torque effect. Unit is shown here being tested.

Relatively small and lightweight, the system requires only about 20 watts of power, primarily for the spin motors. Designers estimate such a system will achieve a practical operating life of well over 20,000 hrs. in space.

Designated CMG-II, the Control Moment Gyro is believed by Nortronics engineers to be the first inertial-grade gyro built specifically to apply a gyroscopic torque effect to space-vehicle stabilization.

For orbital applications, the gyro will provide a momentum vector equal and/or opposite to momentum vectors experienced by a satellite during oscillating perturbations. For non-orbital space probes, the gyro's inherent damping-control characteristics would provide control of motion perturbations, developers claim.

In operation, angular displacements and velocity inputs to the strapped-down gyros will result in precession torques that will then be transmitted to the spacecraft. Perturbations will be damped out by dissipation of the energy in the gyro-float fluid.

• **Background**—The idea for employing integrating gyros as torque sources for satellite control has been expounded for several years by both NASA's Ames Research Center and Massachusetts Institute of Technology scientists. The problem, however, has been development of a suitable gyro—one offering sufficient torque-producing capability and long life without an intolerable weight and power penalty.

Lockheed, too, became interested in such a system for use in its *Agena-D*-associated satellite effort for the Air Force. Following a competitive bid, a contract for $850,000 was awarded Nortronics for development of such a gyro in May, 1962. A supplemental contract of $96,500 was added for a comprehensive reliability study to be performed concurrently. Under its first contract, Nortronics will deliver 10 units—two for test and evaluation and eight production gyros for operational use and spares.

The first complete gyro was delivered to Lockheed last February for preliminary testing. Also early this year, three float enclosures were sent to M.I.T. for environmental and life testing of the gyro spin motors. The units, according to M.I.T.'s first report, easily passed all tests to which they were subjected. Still being life tested by M.I.T., the inertial elements are now well beyond the 2,000-hr. mark, according to Nortronics.

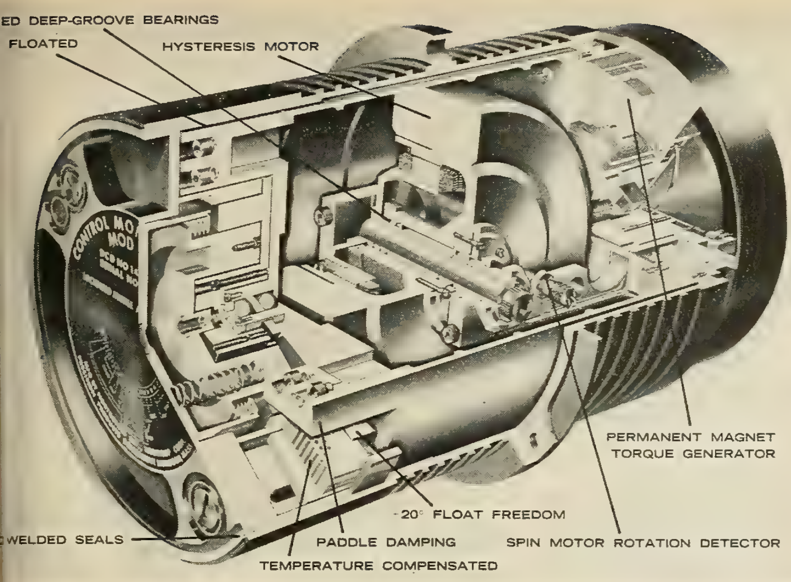
The developmental model weighs 23 lbs., measures 7 in. dia. x 10 in. long, including the center concentric mounting flange.

A fully-floated gyro, it employs wide, deep-grooved, shielded and precisely preloaded ball bearings. The spin motor is designed to withstand 40-g shock and 10-g vibration without damaging the bearings.

Inert-gas fusion welding is used throughout by Nortronics to assure hermetic-seal reliability.

• **Gyro characteristics**—Designed and soon to be produced by Nortronics' Precision Products Department in Norwood, Mass., the CMG-II offers a number of other desirable characteristics considering its application in space:

—Very large angular momentum



CUTAWAY of gyro showing key components of the high-torque inertial units. Fully floated gyro achieves constant damping without external heaters by means of a variable orifice-damping mechanism.

(90×10^6 gm-cm²/sec ± 0.5% at a rated speed of 12,000 rpm). An input rate into the gyro of 1 rad/sec produces a precession torque of roughly 80 in-lb. The spin motor, a synchronous hysteresis type, requires about 20 min. run-up time.

—Very wide angular gimbal freedom (±20° deflection as compared with the ±3° provided by conventional integrating gyros).

—Constant damping maintained without heaters. For floated gyros to provide constant damping, external heaters are normally used to control fluid viscosity during ambient temperature excursions. It is this extra and usually intolerable (for space use) power requirement that has heretofore discouraged use of inertial-grade gyros for direct stabilization control. But by employing an orifice constant-damping technique, the CMG-II obviates the need for a heater. Since gyro-fluid volume varies linearly with temperature, a bellows-controlled shutter is used to vary the orifice-maze area.

Design specs required (1) that gyro-gain settings be externally adjustable from 0.5 to 5.0 (H/C or angular momentum/damping torque), and (2) that a given setting be held constant within ±20% over a temperature range of from 0 to 100°F. Developers believe, however, that with H/C settings from one to three, a temperature range from −65° to 220°F might be obtainable.

- **Unique damper**—The variable orifice-maze design provides for damping torque in excess of 2×10^9 dyne-cm/rad/sec at room temperature using low viscosity fluids (one to three centistokes at 68°F).

To compensate for float-length changes with temperature variations, the float case and damper mechanism are manufactured from titanium. (The float itself is of beryllium with a steel rim). In addition, float axial motion is controlled at the same end of the float as the damping mechanism, leaving the other end axially unrestrained.

The control device is simply a plate attached to the gyro housing and positioned between two closely spaced hemispheres fixed to the float. Clearance between the plate and hemispheres is critical, designers assert. Essentially, the mechanical arrangement limits effects of temperature change to the small control device rather than across the full float length.

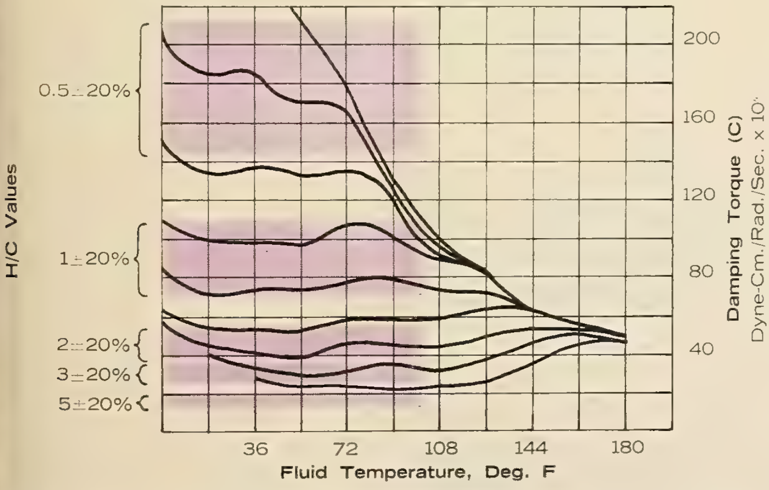
- **Torquing control**—A permanent-magnet torquer, operating on the D'Arsonval meter-movement principle, is capable of better than 10°/hr./ma, designers claim. With a 28v dc supply, 360°/hr. torquing is possible. For continuous-duty operations at current levels up to 65 ma, torquing control of up to 1,000°/hr. can be provided, the company disclosed.

- **Self-test capability**—The CMG-II includes a self-test device providing an output that can be monitored before and after vehicle launch. The device, called a spin motor rotation detector, consists of a stationary pickoff and a rotating magnetically-permeable ring fixed to the gyro wheel.

The pickoff contains a magnetic core encircled by a winding. The ring is designed so that four separate segments pass the pickoff during each complete revolution of the gyro wheel.

By controlling the segment shape, the pulsed-signal sequence from the pickoff indicates wheel rotation direction. By comparing pulse frequency with that of the motor power supply, wheel speed and synchronization can be determined.

Unit cost of the Nortronics Control Moment Gyro, based on production quantities, probably will be less than $25,000, predicts one company spokesman. Since only two of the inertial instruments are required for attitude control in all three vehicle axes of motion, total system costs would then be far less than an attitude sensing and control thrust system using thrust engines, he said. ■



FAMILY OF CURVES obtained by Nortronics engineers for a single gyro using the same flotation fluid but employing external adjustments of the damping mechanism. (Note: $H = 90 \times 10^6$ gm.-cm.²/sec.)

New AF/Mitre Lab May Alter Concepts

Single, flexible computer-based facility could do away with prototypes, allow rapid check of design alternatives, train officers

by Michael Getler

BEDFORD, MASS.—A new Systems Design Laboratory (SDL), potentially of major significance to the U.S. command and control effort, will be put into operation in December at the Air Force Electronic Systems Div.'s huge complex here at L.G. Hanscom Field.

The lab will be run by a joint Air Force/Mitre Corp. team. Its R&D work, and the research and training it will sponsor, will no doubt influence design of virtually every major new U.S. C&C system under consideration.

The lab is designed around the very broad computer capabilities of IBM's 7030 (STRETCH) system, used in combination with advanced programming techniques under development by Mitre.

It is intended to provide a single, highly flexible computer-based laboratory for testing all C&C system design alternatives very early in the planning stages, prior to commitment to build any particular system.

In effect, SDL would remove the need for costly development of prototypes for individual C&C systems, but more importantly, as Col. Anthony Debons, Director of Computers at ESD, points out, "it will not only get us away from prototypes, but from developing prototypes that don't work."

Col. Debons and David R. Brown, associate technical director in Mitre's systems research and design lab, have been given responsibility for putting SDL into operation.

In addition to its impact on C&C design and program philosophy, SDL's establishment is expected to cause a spurt in ESD industry contracting under the division's applied research program, and may also play a key role in training military officers likely to have C&C responsibility.

• **Proposal due**—AF officers told M/R that a proposal to Systems Command chief Gen. Bernard A. Schriever now in the works at Hanscom calls for training top-echelon officers of General and Flag rank, in addition to some junior officers, in the simulated command post at SDL.

"We hope to provide the feel for running a C&C situation within this lab," says Col. Debons. "We can structure C&C as we know it, and by putting an officer in this, adding his real experience to technical experience, he can try this world out and find out what this thing is all about."

Early efforts at SDL are expected to be concentrated on the AF's Post-Attack C&C system (481L), now under development, and also on the 473L AF Headquarters system. Further along, officials expect the lab may assist in C&C projects for the U.S. Strike Command (probably to be designated 492L) and for an Aerospace Reconnaissance system.

AF officers point out that there is no requirement that C&C system SPO's (System Program Officers) use the new laboratory on their individual projects. However, Col. Debons asserts that "when the SDL concept is fully developed we expect most of the SPO's will be convinced of its advantages and will find wide use for it."

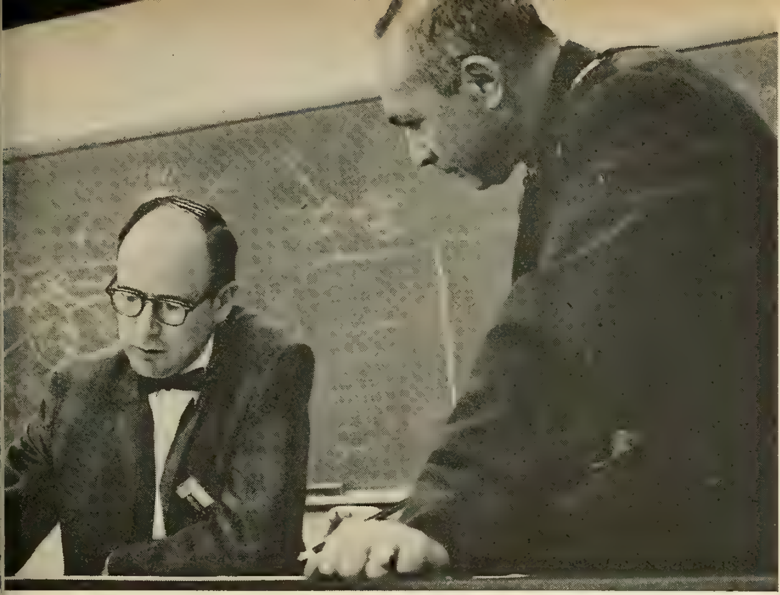
Debons points out that some reluctance to use this unique facility and program approach in its early stages is anticipated—and is actually two-sided at this point. "Many SPO's don't know how to use a facility of this sort at this stage," he says, "and we will clearly have to demonstrate its capability." However, he adds, "there is certainly a reluctance by our own technical people to move too rapidly until we have more experience with these tools."

• **Provides the quick look**—Debons recognizes the economies of a single, flexible facility as compared with individual prototypes. But he adds that "the criterion for the military for important new systems is very seldom money but, more realistically, does it work and can you have it in time to be effective? The concept of this lab is to help when needed. SDL will enable advanced planners to try out notions very quickly, before a breadboard is built, to get a measure of all relative system design problems."

Brown also points out that new time-sharing techniques being developed for the 7030 will allow simultaneous modeling of more than one system at a time in SDL.

Debons feels that new C&C tech-

ARCHITECT'S DRAWING of AF-Mitre Corp.'s $10,000,000 Systems Design Laboratory.



TWO CHIEF SDL planners, Mitre's David R. Brown (left) and AFESD's Col. Anthony Debons, check status report on new 46,000-sq.-ft. lab due to open in December.

niques emerging from this lab will enable SPO's to write more detailed specifications much earlier in C&C planning than has so far been possible. He believes that this, in turn, will give industry better guidelines, will allow work on a fixed-price contract base, cut lead times, and reduce cost.

The instrument with which AF/Mitre scientists hope to implement the modeling of a wide range of systems with the same basic computer program is the Mitre-developed Advanced Data Management (ADAM) system.

Essentially, ADAM puts to C&C use a concept which has been applied in commercial programs—namely, that highly flexible systems can be programmed to include command functions which cut across lines and are common to all types of C&C systems, while retaining the capability to rapidly model individual systems with certain unique and changing requirements.

• **May have pay-off in field**—While ADAM is aimed primarily at experimental modeling and design of C&C systems at SDL, both AF and Mitre officers feel that its real payoff may come in use with operational systems, with the same flexibility developed for a C&C lab filling the military need for more user-oriented systems.

According to Mitre, ADAM generalizes these common data-management functions by performing them as functions, independent of the data form or content specific to an individual system.

Its flexibility, they claim, stems from the ability to accept specifications for data form and content for a particular system and operate with them, thereby modeling that system. As the specifications change, additions can be made rapidly. ADAM design, they say, provides for user specification of input/output data formats, reports, and displays, for changes in message processing, and for insertion of computer routines for calculations or processing specific to a particular system being modeled.

Though ADAM can be modified while operating, Mitre officers stress that it is not a learning machine. "You can describe certain conditions," says Mitre's Oliver Kinney, "and you can redesign the manner in which the system operates on-line in real-time. We are trying to put into the hands of the military user the ability to communicate with the system, to enable him to make changes in format and handle new inputs in an unpredictable C&C situation without having to go through the programming cycle."

Kinney says the most experimental portion of the system is the highly flexible general-purpose translator being built. The program compiler used with ADAM is eventually expected to be able to handle any program language.

Kinney says a large part of ADAM's flexibility rests on its "dynamic allocation" of computer storage. Both main computer memory and secondary bulk storage are allocated to the programs and data tasks as needed during operation. Through this design, they say, ADAM programs are built to handle operations whose requirements for data and processing sequence may be implied in the input operation request.

• **Early use causes optimism**—An early version of ADAM, developed in conjunction with the firm's model of a portion of the 473L system, has already proved its usefulness, Mitre reports, by making it possible to go into experimental operation on another L-system development "at least a year earlier than production of a new computer model would have allowed."

Kinney also points out that ADAM still requires study. For example, he cites the question of response time: "we don't know just how fast it is over a wide range of functions at this point."

Debons and Brown point to two major factors that should increase industry-AF/Mitre contact in C&C development:

1) The applied research program, run from Debon's office with close Mitre tie-in, probably will expand due to establishment of the lab. The stepped-up program will focus on reduction of system modules, new mathematical systems evaluation, and common language techniques.

2) The Congress on the Information Sciences, held for the first time last year, supplies a major forum for C&C advances. AF and Mitre, who sponsored the first meeting, will also propose sponsorship of a Fall 1964 meeting. Last year's meeting (M/R, Dec 3, p. 16) brought many of the most pressing C&C problems into the open before a wide audience and is considered to have given considerable impetus to the shift in emphasis from hardware to the so-called "software" aspects of system design.

Most of the hardware for the 46,000-sq.-ft., two-story structure (valued in excess of $10 million fully equipped) at Hanscom is already on-hand, with exception of high-speed printers for computer read-out. In addition to the 7030, the facility will also include a smaller IBM 1401 computer, and associated equipment such as consoles, CRT displays and input/output terminals.

Also, a small computer being developed in-house by Mitre will be added later to study integration of automated command system centers.

• **Concept proposed in '59**—SDL actually grew out of the 1959-60 Winter Study Group, which met at ESD at the direction of Gen. Schriever to tackle the problems of an expanding C&C effort. It was concluded at that meeting, in the light of the cost and duplication of individual prototype equipments, that a facility ought to exist at ESD, with an advanced computer and support equipment, where design verification of computer-based C&C could be done. "It had to give us valid, quantitative information rapidly to decide among design alternatives," Debons states, "and what we are building here is pretty much what the group recommended."

The lab is also expected to study operational or near-ready systems with an eye towards possible retrofit with more flexible programming. ■

New Printer Is Fast Computer Mate

MELBOURNE, FLA.—Engineers at Radiation Inc., have taken a major step toward matching available high-speed digital computer capabilities with extremely rapid off-line data printout.

The firm's new high-speed printer, developed specifically for the AEC's Lawrence Radiation Laboratory under a $348,000 contract, is reportedly capable of a maximum print rate of 62,500 alpha-numeric characters per second. This figure is based on use of a magnetic tape input moving at 112.5 ips with a tape-packing density of 556 bits per inch.

Five other intermediate speeds, ranging from 15,000 to 60,000 characters per sec, are also built in.

The maximum data rate, engineers here note, is comparable to data transfer rates between many existing digital computers and their magnetic tape output units. Automatic transfer of data between multiple tape units is also possible without interrupting printout.

The device was slated for installation at the AEC laboratory late in June. Printer demonstrations for NASA and military personnel are also expected.

- **Some old methods refined**—Actually, most of the basic recording techniques used in the high-speed printer are not new, but they have been refined, incorporated on a large scale, and combined with solid-state electronic design and a new high-speed paper handling and transport system.

In addition to the printer, the basic equipment in the Radiation system includes two 5½-ft.-high electronic racks which house the tape-printer interface logic circuitry.

- **Key feature**—According to the firm, the key to the high-speed design is the electrosensitive multi-stylus recording technique that eliminates the mechanical inertia of high impact mechanisms and permits a dry, immediately available output without subsequent processing.

Data is printed a line at a time with each line containing 120 characters; 31,250 lines per min. can be printed. Each line is formed by transmitting seven sequential groups of 600 pulses, derived from 5x7 bit matrix-character generators, to 600 fixed styli (five for each character) as the 12-in. wide electrosensitive paper is driven beneath a closely spaced row of fixed styli at a constant speed. Maximum paper transport speed is 96.7 ips.

- **Styli operation**—The tungsten alloy styli are selected according to the character to be printed and are energized through a transistor drive with high velocity (200-300v) current pulses. Passing these controlled pulses through the paper causes the chemical reaction that produces the figures on the chemically impregnated recording paper.

The styli, which rest against the paper under about 3-4 grams pressure each, are contained in six individual heads of 100 styli each and can be replaced either by module or individually.

Paper supply can handle 45 minutes of maximum-speed operation without interruption. The printer can be stopped manually or automatically through a code recognition or through indication of a system malfunction.

- **Error indication**—Parity checks are performed on each character, with error detection causing a special symbol to be printed in lieu of the character in error.

Control of the printer and output data format is accomplished by preprogramming the input data tape. ■

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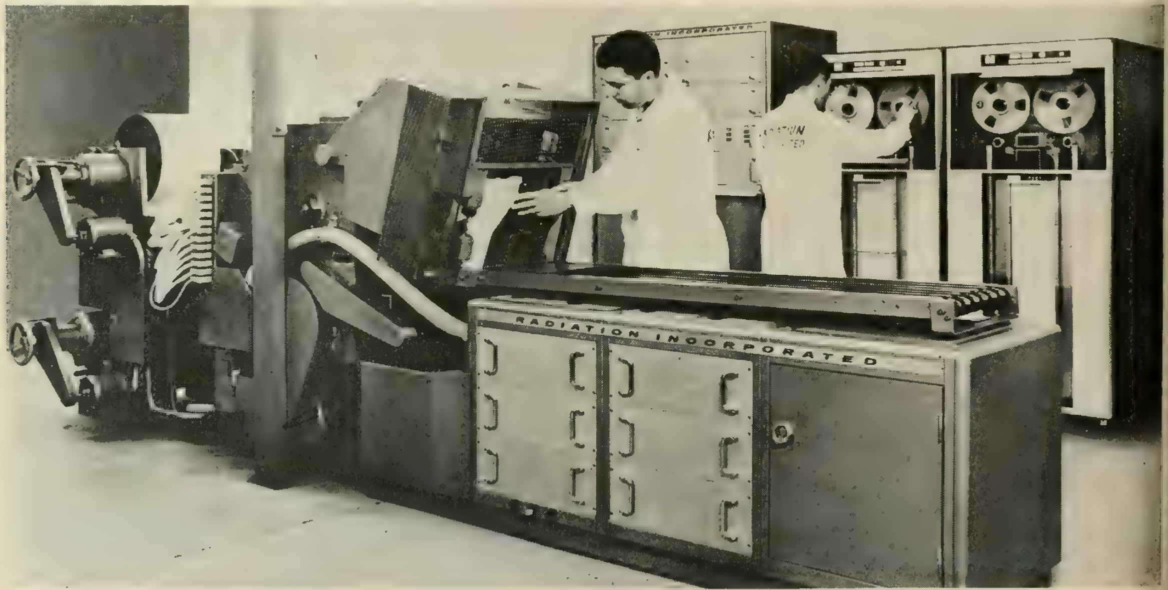

OVERALL VIEW of Radiation Incorporated's 62,500-character-per-second off-line data printer.

Microwave Switch

Microwave Associates is marketing a double-pole double-throw solid-state microwave switch. The MS-8313-2LIND operates over a frequency range of 700 to 1600 mc, with peak power capabilities of 500 watts and a CW power capability of four watts. It has a switching speed capability of less than 200 nanoseconds. It is designed as a lobing switch for radiometer noise reference with no signicant increase in system noise figure because of its low loss.

The MS-8313-2LIND can include a driver which enables the switch to be operated from a 110v 60-cycle ac source.

Circle No. 226 on Subscriber Service Card

DAP Transistors

A series of three-ampere diffused lloy power DAP transistors is available rom Bendix Semiconductor Div. The EDEC type numbers assigned to these ower transistors are 2N2282-2N2284 nd 2N2467-2N2469. These germanium NPDAP transistors are designed for fficient high-current switching at fast witching times. The diffused base gives ery low input resistance and high cut-ff frequency while maintaining high reakdown voltage. These devices are apable of switching up to 300 watts n microseconds over a wide tempera-ure range.

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ight-Controlled Resistor

The Solid State Electronics Corp. s marketing a solid-state isolated light-ontrolled resistor. The unit is a four-erminal photoelectronic device that ombines a light source and a semiconuctor photocell packaged within an paque enclosure. Energy transfer rom the drive to the output is acomplished by means of light radiation. wo models are available. The Model 51 is designed with an incandescent ght source. The Model 661 utilizes a as discharge light source.

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ilicon Rectifiers

The RCA Semiconductor and Marials Div. has available silicon conolled-rectifiers, designated RCA-N681 through 2N689 and RCA-N842A through 2N1850A, which are l-diffused, three-junction devices. The CA-2N681 units may be used in pplications requiring blocking-voltage pabilities from 25 volts to 500 volts d forward-current capability of 16 mperes (average value) or 25 amperes ms value).

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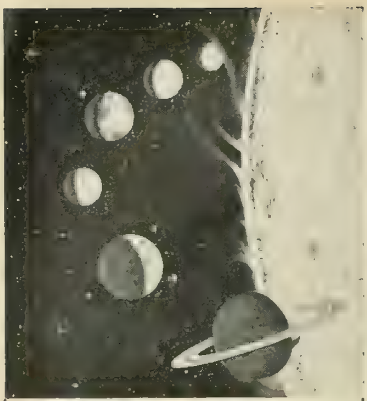

AERO-THERMODYNAMICS

North American Aviation's Space and Information Systems Division recognizes the role of research and its importance to the successful development and synthesis of manned and unmanned space vehicles of the future.

The Aero-Thermodynamics Department is an applied research division of S&ID and is engaged in advanced state-of-the-art studies associated with many interesting aerospace studies and concepts.

Employment opportunities are available to senior engineers and scientists who have the background to conduct basic and applied research and conceptual design studies in aero-thermodynamics. A broad spectrum of aerothermodynamic facilities are available to provide engineers and scientists with experimental verification of their theoretical studies.

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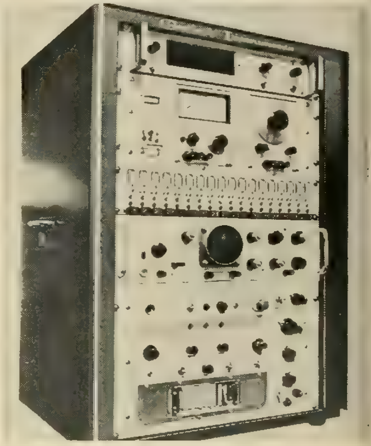
All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

SPACE AND INFORMATION SYSTEMS DIVISION
North American Aviation

New Product of the Week:

Telemetering Station



A portable, miniaturized, 18 channel telemetering ground station is available from Genisco Instrument.

Weighing 140 lbs., it is 32 in. high and 19-in. wide. The band pass filters have less than 3 db variation over passband and greater than 20 db attenuation at adjacent band edges. Linearity is ±0.5% bandwidth, and drift is not more than ±1% over a 36-hr. period after 10 min. warm-up.

Besides the 18-channel discriminators, the unit contains: telemetry receiver, VTVM, oscillator, frequency counter, oscilloscope, recorder, and test point switching to observe and measure the composite signal, isolated subcarriers, and intelligence information.

Circle No. 230 on Subscriber Service Card

Subminiature Inductors

Vanguard Electronics has available a series of subminiature toroidal inductors, Series 93, with a 0.27 x 0.15 in. size. Series 93 covers an inductance range form 10 μh to 1000 μh. The units are designed and fabricated to meet MIL-C-15305, grade 1, class B (−55°C to +125°C), making them shock resistant, moisture- and even immersion-proof. In addition, Series 93 is also available in transformer configuration. It can be obtained with either two windings or tapped with up to four terminals and provides a selection from an overall inductance range from 0.01 μh to 1000 μh.

Circle No. 231 on Subscriber Service Card

FM Transmitter

Carrier frequency stability of ±0.01% is maintained in a solid-state FM transmitter developed by Physionics, Inc. The unit was designed specifically for the reliable transmission of telemetry information from space vehicles. The transmitter will produce a carrier output of 3.5 watts at any specified frequency in the 215- to 260-mc band.

Stability of ±0.01% is maintained without degradation of modulating components over a temperature range of 0° to 85°C with deviation sensitivity of 100 kc/volt constant within ±1 db. Filter networks incorporated in the power leads attenuate conducted and radiated noise.

Circle No. 232 on Subscriber Service Card

Microminiature Diodes

Silicon micro diodes in the 1,000v-to-1,500v range are available from MicroSemiconductor Corp. Low Leakage currents of 10-20 nanoamperes at 1,200v are standard. Current handling capabilities are 100 milliamps to one amp.

Applications are in miniature multipliers and miniature high-voltage powe supplies. Device reliability and performance meet or exceed all applicabl MIL-S 19500C and MIL-STD-202 requirements.

Circle No. 233 on Subscriber Service Card

Fast-Switching Transistor

A 10-amp diffused alloy powe DAP transistor is available from Bendi Semiconductor Div. The 2N2212 is designed for efficient high-current switching at fast switching times. The diffuse base gives very low input resistance an high cutoff frequency while maintaining high breakdown voltage. The un is capable of switching up to 1,20 watts in one to five microseconds ove a wide temperature range.

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ComSat Role Debated

In contrast to the recent proposal by RCA Chairman David Sarnoff to merge all U.S. commercial communications operations into the Government-sponsored Communications Satellite Corp., International Telephone and Telegraph Corp. is arguing that ComSat Corp. should remain in the role of a "carrier's carrier," providing relay services to other communications companies rather than directly to the public.

Sarnoff's suggestion came last April in a letter to Chairman Leo D. Welch of ComSat proposing that, because advancements in cable communications technology may well reduce the relative value of satellite communications relays, ComSat should be permitted to buy and operate all overseas telephone and telegraph operations to assure its commercial success. Sarnoff reasoned that such a commercial monopoly could most efficiently compete with foreign government communications monopolies.

Mergers and Acquisitions

Control Data Corp., Minneapolis, has acquired rights to the Digigraphic System and certain other assets relating to development and manufacture of the System from the Itek Corp., Lexington, Mass. The Digigraphic System is to provide direct "real-time" communication between man and computer. The System, when fully developed, is expected to have widespread applications in machine tool control, management of weapons systems, and automatic or semi-automatic conversion of existing graphic documents into digital form. Acquisition is part of CD's overall plan to broaden market areas and product lines. Terms of the acquisition involved an undisclosed amount of cash and other considerations. . . . *Consolidated American Services, Inc., (CONAM), Hawthorne, Calif., supplier of nondestructive testing, missile cleaning, and nuclear decontamination services, has acquired all assets of Facilities Management Corp. Under terms of acquisition, CONAM received all assets of FM, including contracts and backlog facilities and equipment and key personnel for an undisclosed amount of stock. FM is currently under contract with the Air Force for complete management of facilities on Wake Island. This includes maintenance of aircraft, billeting and supervision of crews, operation of shops, and all plant engineering and management. The new acquisition will be operated as a subsidiary of CONAM.* . . . Huggins Laboratories, Inc., Sunnyvale, Calif., has purchased all assets of Applied Systems Corp., Palo Alto, Calif., AS was formed in April 1961 to provide technical talent for the aerospace industry, specializing in the field of infrared. The firm has conducted studies for prime aerospace contractors in the areas of telemetry, electromagnetic interference, satellite systems and subsystems, solar power supplies, and infrared optics. . . . *Genisco, Inc., Compton, Calif., has bought the Northridge, Calif., plant of Airpax Electronics, Cambridge, Md., and Fort Lauderdale, Fla. Airpax sold the plant to strengthen its financial position and to consolidate the manufacture of telemetry devices in its Seminole Div. Plant.*

Industry Facilities

Operations Research, Inc., has occupied a new $1.5-million headquarters building in Silver Spring, Md. The five-story building is expandable to eight floors. The firm initially occupies 27,500 sq. ft., all of the fourth and fifth floors and parts of the first and third. In addition to the Silver Spring headquarters, ORI maintains facilities in Santa Monica, Calif. It employs over 200 people, including 125 professional staff members and research assistants. ORI provides scientific-method management to Government and industry. . . . *Hoffman Electronics Corp., Los Angeles, has announced plans to substantially enlarge company facilities at El Monte, Calif., by construction of two new buildings aggregating 165,000 sq. ft. The addition will enable the company to vacate its Los Angeles office, which it has occupied since 1941. The new facility joins the company's Military Products Div. and Semiconductor Div. in the 38-acre Hoffman Electronic Park. The move will increase total building space in the Park to 387,000 sq. ft.* . . . Dow Corning Corp., Midland, Mich., has broken ground on a multimillion dollar, 60,000-sq-ft plant in Elizabethtown, Ky. The new plant, expected to be finished by January, will produce silicon rubber-base sealants and caulking materials for the missile/space, automotive, appliance and building construction industries.

New Firms and Divisions

Superior Cable Corp., Hickory, N.C., manufacturers of plastic insulated wire and cable, has announced the formation of a new Systems Equipment Div. The new division will be responsible for design, development and manufacture of products and equipment for communications and signal systems in the electronics, telephone and television fields.

Where the Money Is

More than 42% of the nation's military prime contract money for the first three-quarters of FY '63 went to four states, according to the Commerce Clearing House, topical law reporting publishers. California led with 23% of the $17.9 billion; New York followed with 9%. Ohio and Texas each received 5%.

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contracts

AIR FORCE

$10,000,000—**Ling-Temco-Vought, Inc.,** Dallas, for development of a nuclear-powered low-altitude supersonic vehicle (LASV).

$7,095,250—**Vitro Corp. of America, Vitro Services Div.,** Silver Spring, Md., for management and operation of Air Proving Ground Center land range test areas and Eglin Gulf Test Range in Florida.

$7,000,000—**Control Data Corp.,** Minneapolis, for design, development and installation of a Real Time Computer System (RTCS) at Cape Canaveral.

$5,800,000—**Ling-Temco-Vought, Inc.,** Dallas, for work on a classified project.

$4,900,000—**General Electric Co.,** New York City, for continued production of radar equipment.

$1,600,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Long Island City, N.Y., for navigational computer spare parts, components, etc.

$1,200,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for engineering and related training services supporting the *Atlas* missile program.

$1,000,000—**American Bosch Arma Corp.,** Garden City, N.Y., for guidance equipment for *Atlas* missiles.

$1,000,000—**Aerojet-General Corp.,** Azusa, Calif., for development of a reinforced plastic solid rocket motor casing.

$752,000—**Cook Electric Co.,** Chicago, for ground wire communication equipment for use in the missile technical operations communications system.

$420,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for hot gas secondary injection thrust vector design for solid propellant rocket motors.

$188,000—**Bell Aerosystems Co.,** Buffalo, N.Y., for demonstration of a manuevering satellite propulsion system.

$185,000—**Canoga Electronics Corp.,** Van Nuys, Calif., for modification of MPS-19 radar.

$100,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Great Neck, N.Y., for development of a laser gyro.

$89,000—**Edgerton, Germeshausen & Grier, Inc.,** Boston, for research directed toward experimental studies and investigation of a satellite optical beacon system.

ARMY

$8,000,000—**Bendix Corp.,** Baltimore, for electronic equipment.

$6,200,000—**Western Electric Co.,** New York City, for research and development on the *Nike II Zeus* weapon system.

$5,800,000—**Hercules Powder Co.,** Wilmington, Del., for missile propellants.

$5,000,000—**General Electric Co.,** New York City, for electronic equipment.

$2,000,000—**General Telephone and Electronics Corp.,** Needham, Mass., for classified electronic equipment.

$1,900,000—**Murray J. Shiff Construction Co.,** for construction of **Apollo** propulsion development facilities at White Sands Missile Range, N.M.

$1,800,000—**Raytheon Co.,** Lexington, Mass., for production of *Hawk* missile battery control components.

$1,000,000—**Philco Corp.,** Philadelphia, for electronic equipment.

$610,000—**Kaminer Construction Co.,** Chamblee, Ga., for additions to missile launching facilities at Cape Canaveral Test Annex, Air Force Missile Test Center and Patrick Air Force Base.

$289,000—**Radio Corp. of America, Defense Electronic Products Div.,** Camden, N.J., for continued performance leading to the development of Multisystem Test Equipment (MTE) for various missile systems.

$241,000—**General Electric Co., Defense Electronics Div.,** Syracuse, N.Y., for high-power acquisition radar for the *Nike* missile system.

$152,000—**Aerojet-General Corp.,** Downey, Calif., for warhead for the NATO version of the *Hawk* missile.

$69,000—**Cornell Aeronautical Laboratory,** Buffalo, N.Y., for wind tunnel tests of the *TOW* missile.

$59,636—**Electronic Communications, Inc., Research Div.,** Timonium, Md., for development of millimeter wave components and techniques for use in measurement systems operating at 140, 280 and 420 gigacycles.

NAVY

$8,700,000—**Sparton Corp., Sparton Electronics Div.,** Jackson, Mich., for production of high-reliability electronics equipment (5 contracts).

$5,500,000—**General Precision, Inc.,** Glendale, Calif., for production of submarine weapons-control systems.

$5,500,000—**Westinghouse Electric Corp.,** for nuclear reactor development at Pittsburgh, and for construction of tubes for the *Typhon* missile system at Elmira, N.Y.

$5,000,000—**McDonnell Aircraft Corp.,** St. Louis, Mo., for work on weapon system training components.

$3,200,000—**Sperry Rand Corp., Univac Div.,** for classified work, development of a naval tactical data system, and production of electronic peripheral devices (several contracts). Work to be performed at St. Paul, Minn., and San Diego.

$2,700,000—**Admiral Corp.,** Chicago, for production of radar indicators.

$1,200,000—**Northrup Corp.,** Anaheim, Calif., for *Polaris* missile checkout equipment modification.

$1,000,000—**Lockheed Missiles and Space Co.,** Sacramento, Calif., for *Polaris* missile motors.

$398,000—**Lear Siegler, Inc.,** Santa Monica, Calif., for engineering services to the Pacific Missile Range.

$100,000—**American Machine & Foundry Co., Advanced Products Group, Hydrospace Div.,** Buffalo, N.Y., for development of a Sonar Train Group for the Underwater Sound Laboratory.

Geoscience Ltd., Solana Beach, Calif., for studies of thermal and electrical conductivity measurements of biological fluids and tissues which have been exposed to physical fields such as temperature and radiation (undisclosed amount).

NASA

$15,600,000—**General Dynamics Corp.,** San Diego, for continued development of the *Centaur* upperstage vehicle.

$6,000,000—**Douglas Aircraft Co.,** Santa Monica, for receipt, assembly, checkout and launch of *Delta* space research vehicles.

$3,600,000—**Lear Siegler, Inc., Electronics Instrumentation Div.,** Anaheim, Calif., for modification and expansion of existing instrumentation systems at the Marshall Space Flight Center.

$3,400,000—**Aerojet-General Corp.,** Sacramento Calif., for further development and test facilities for the M-1 booster engine.

$3,200,000—**Aerojet-General Corp.,** Azusa, Calif. for continued work on the SNAP-8 program

$1,000,000—**Lear Siegler, Inc.,** Anaheim, Calif. for research designed to maintain future aero space pilots and astronauts in optimum physio logical state while on duty in flight.

$925,000—**Garrett-AiResearch,** Phoenix, Ariz., fo production of pre-valves for the first static fir ing of the *Saturn C5* launch vehicle.

$886,055—**California Computer Products, Inc** Anaheim, Calif., for performance of additiona work on the *Nimbus* satellite-borne and groun station command and control systems.

$798,000—**Grafe-Wallace, Inc.,** Boise, Idaho, fo construction of an instrument laboratory buil ing at the Marshall Space Flight Center.

$729,000—**American Dewatering Corp.,** Hunt ville, Ala., for buildings, observation bunke and water lines for the F-1 engine test stan

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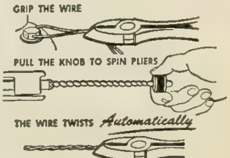

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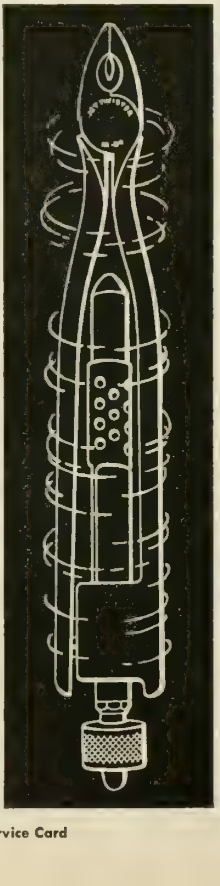

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names in the news

Jack F. Steele: Named manager of specialized marketing for General Motors Corp.'s AC Spark Plug Div.'s Milwaukee, Wis., operations.

Frank S. Lyndall, Jr.: Appointed manager of staff engineering in the quality and reliability engineering department of Atlas Chemical Industries, Inc., Wilmington, Del.

Llewellyn J. Evans, Richard Hutton, and George Titterton: Appointed senior vice presidents at Grumman Aircraft Engineering Corp., Bethpage, N.Y. **J. B. Rettaliata, Ira Grant Hedrick, and A. James Zusi** appointed vice presidents.

Robert R. Pierce: Named manager of purchasing for General Dynamics/Electronics, San Diego, Calif.

Charles M. Downs: Appointed advertising and sales promotion manager for Raytheon Co.'s Semiconductor Div., Mountain View, Calif.

Col. Charles W. Gordon (USAF-ret.): Appointed regional manager for the U.S. Air Force and Federal Aviation Agency liaison in the government products division of Adler Electronics, Inc., Washington, D.C.

Carl F. Holland: Named manager of marketing for Greer Olaer Products Div. of Greer Hydraulics, Inc., Los Angeles.

Francis P. Cotter: Elected a vice president of the Westinghouse Electric Corp., Pittsburgh.

William C. Heath: Appointed product development manager at NTH Products, Inc., El Cajon, Calif.

Dr. Arthur McCoubrey: Appointed director of the new solid-state activity of Varian Associates, Beverly, Mass.

Arnold R. Kaufman: Promoted to president of the Triad Transformer Corp., Venice, Calif.

Dr. Richard C. Clippinger: Appointed associate director of product planning at Honeywell Electronic Data Processing, Wellesley Hills, Mass. **Dr. Reinhold P. Sell** appointed assistant director.

Anthony J. Orlando: Named marketing manager of the DeVar-Kinetics Div. of Consolidated Electrodynamics Corp., Bridgeport, Conn.

Frank C. Dupre: Appointed president of Kollsman Motor Corp., Dublin, Pa.

R. F. Wilkinson: Appointed director, market development-chemicals, for Amoco Chemicals Corp., Chicago.

Donald L. Pyke: Rejoined Thompson Ramo Wooldridge, Inc., Los Angeles, as assistant to the vice president, research and development.

F. Donald Calkins: Promoted to assistant general manager at Edcliff Instruments, Inc., Monrovia, Calif.

Stephen A. Denman: Named manager of the Production Engineering Div. of National Water Lift Co., Kalamazoo, Mich.

James A. Whitaker: Named sales engineer in the Hawthorne, Calif., office of Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.

William Ussler, Jr.: Named manager of the Communications Engineering Dept., Military Electronics Div., General Atronics Corp., Philadelphia.

E. C. Boycks: Appointed product manager for systems at the Computer Div. of Packard Bell Electronics, Los Angeles.

Arthur W. Dobson: Appointed manager of marketing development, Government Products Group, Universal Match Corp., Stamford, Conn.

John J. McKenna: Appointed field service engineer for the Aero-Space Div. of Walter Kidde & Co., Inc., Belleville, N.J.

Eugene J. Bourque: Appointed works manager of the Diode and Rectifier Dept. at Motorola's Semiconductor Products Div., Phoenix, Ariz.

Dr. Lee S. Richardson: Joined the staff of Foote Mineral Co., Exton, Pa., as manager of metallurgy and ceramic research.

Lewis C. Meyer: Appointed financial coordinator for the Communications Satellite Corp., Washington, D.C.

William A. Craven, Jr., and Elvin E. Herman: Promoted to assistant directors of the research and development division of Hughes Aircraft Co.'s Aerospace Group, Culver City, Calif.

John F. Barrow: Named marketing manager for the Riverdale, Md., plant of ACF Electronics Div. of ACF Industries, Inc.

B. J. Smith: Appointed assistant to the vice president for advanced technology programs at Rocketdyne's Solid Rocket Div., McGregor, Tex.

F. X. Marshall: Appointed manager of *Centaur* program coordination and scheduling at General Dynamics/Astronautics, San Diego.

Walter B. Brewer, Jr.: Promoted to associate general manager of the San Bernardino, Calif., Operations of Aerospace Corp., and general manager of the advanced planning division. **Dr. Donald A. Dooley** elected a corporate vice president and general manager of the engineering division.

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JULY

Seventh National Conference on Aerospace Education, National Aerospace Council, Hotel Deauville, Miami Beach, Fla., July 7-11.

IEEE 1963 International Symposium on Space Telecommunications, sponsored by Professional Technical Group on Antennas and Propagation, Boulder Laboratories, National Bureau of Standards, Boulder, Colo., July 9-11.

Meteorological Support for Aerospace Testing and Operation, sponsored by AIAA and American Meteorological Society, Ft. Collins, Colo., July 10-12.

National Association of Power Engineers, National Convention, Everglades Hotel, Miami, July 14-19.

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

The Sixth Annual Institute of Missile Technology, sponsored by the University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado. *Electrical Design News* and *Design News,* University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference sponsored by NBS Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

Western Electronic Show and Convention Cow Palace, San Francisco, Aug. 20 23.

AIAA Simulation for Aerospace Fligh Conference, Deshler-Hilton Hotel Columbus, Ohio, Aug. 26-28.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

American Institute of Electrical Engineer Pacific General Meeting, Davenpor Hotel, Spokane, Wash., Aug. 26-29

18th Annual Conference of the Association for Computing Machinery, hoste by the University of Denver, Denve Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

International Symposium on High-Temperature Technology, sponsored b Stanford Research Institute, Asiloma Calif., Sept. 8-11.

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That NASA Budget

NO DISCUSSION of the actions taken by the House Space Committee in trimming nearly $500 million from the budget of the National Aeronautics and Space Administration would be appropriate without first commending that committee for its hard work this year.

It has been one of the most effective committees on the Hill, and its members have put in long hours probing into intimate details of the NASA budget. As a result, they are well-informed, technically oriented and well aware of the importance of the programs concerned.

Committee Chairman George Miller of California has wisely delegated to his subcommittees full authority and support in their hearings on the NASA budget. This change from previous leadership, where tight central control was enforced, has been a great improvement. It has enabled the smaller subcommittees to acquaint themselves well with specific technical areas.

For good reason, the findings of the subcommittees have been regarded with respect by the committee as a whole. The House itself also can rest assured that, with this approach, a conscientious job was done by the Committee.

Because we disagree with some recommendations of the committee—one in particular—does not mean that we do not have great admiration for the way its members went about their jobs this year. They are to be congratulated as one of the hardest-working and knowledgeable committees in Congress.

We must, however, take violent issue with the manner in which the committee dealt with the budget request for the *Apollo* lunar-landing program. *Apollo* suffered the largest single reduction in the budget recommendations—some $120 million or almost 10% of the more than $1.2 billion requested by NASA for *Apollo*.

We still are in a competition with the Soviet Union for the first manned lunar landing. Development of the technology leading to this capability, as well as the landing itself, is of first importance to the nation. Nothing should be permitted to impede the fastest possible pace for Project *Apollo*.

The lack of full financial support for the *Apollo* and *Gemini* programs was one of the factors involved in the resignation of D. Brainerd Holmes as boss of the manned spaceflight effort.

NASA Administrator James E. Webb himself made it clear that the agency was coming to the Hill with a budget that was pared to the point where the lunar program was suffering. He made it quite plain in his discussions of the budget that the higher requests considered and rejected by the Administration would have moved the nation more quickly toward a successful lunar expedition. The failure to seek a supplemental appropriation for the preliminary *Gemini* program already has set back both the *Gemini* and *Apollo* timetables.

It was discouragement over these financial facts, together with other problems, which led Holmes to conclude he would be better off back in an industry job.

We had hoped his resignation would serve as an alarm signal to members of the Congress. The budget for the manned spaceflight programs was a crippled budget when it was brought to the Hill. To cripple it further is to give the Russians an even greater advantage in the race for the lunar landing.

MANY CRITICS lately have charged that this nation has no business in a race for the *Moon* with the Soviets. We think it does and we see nothing wrong with the use of the word. This nation is engaged in a race with the Russians for political and economic predominance in the world and the lunar race certainly will and is having its impact on that.

There has been considerable talk about the technological fall-out from the space program which will benefit the nation enroute to the lunar landing. This past week, NASA came up with some specific examples of what we are gaining.

The space agency offered to industry details of a number of products and processes culled from its various centers. This is part of the Technology Utilization Program, which NASA has established to spin off space technology to industry. A look at some of these items gives an idea of what we stand to gain in technology from the space programs:

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—Elastic thermal conductive material, a wire-impregnated rubber material that provides both elasticity and thermal conductivity, can be used to regulate or limit temperature differential.

—Single-element plastic universal joints, specifically designed to transmit thrust through a flexural joint (as opposed to the normal joint, which mainly transmits either torque or axial thrust). Of simple construction, these joints are especially adaptable to small-capacity units.

Details of these and other items can be obtained from the Director of Technology Utilization at NASA headquarters in Washington. We believe they provide a good example of some of the side benefits of our space program which may be put to use elsewhere in U.S. industrial technology.

To speed development of this technology of the 1970's as well as to beat the Soviets in the lunar race itself, it is necessary to move the *Apollo* program forward as rapidly as possible. But a race requires two entrants.

The cuts in the *Apollo* program are crippling. They should be restored.

William J. Coughlin

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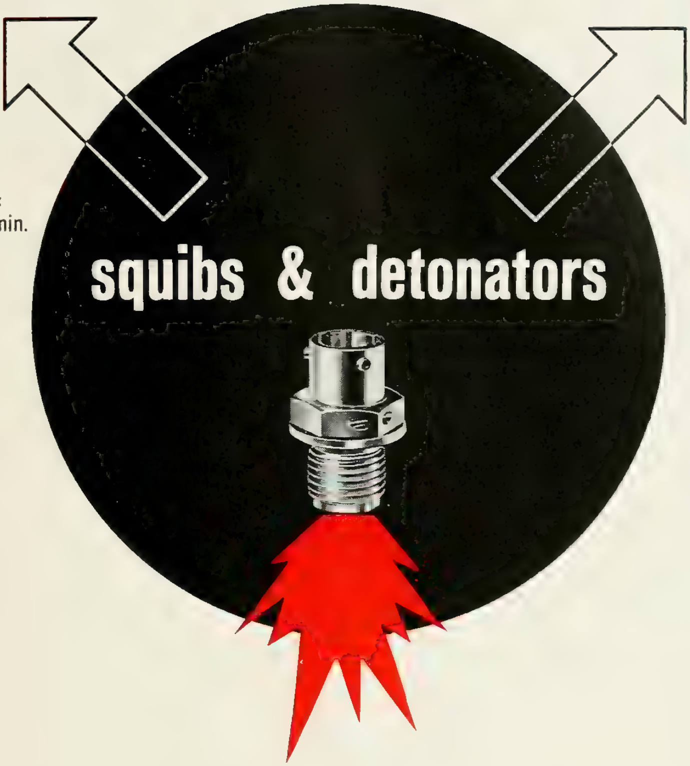

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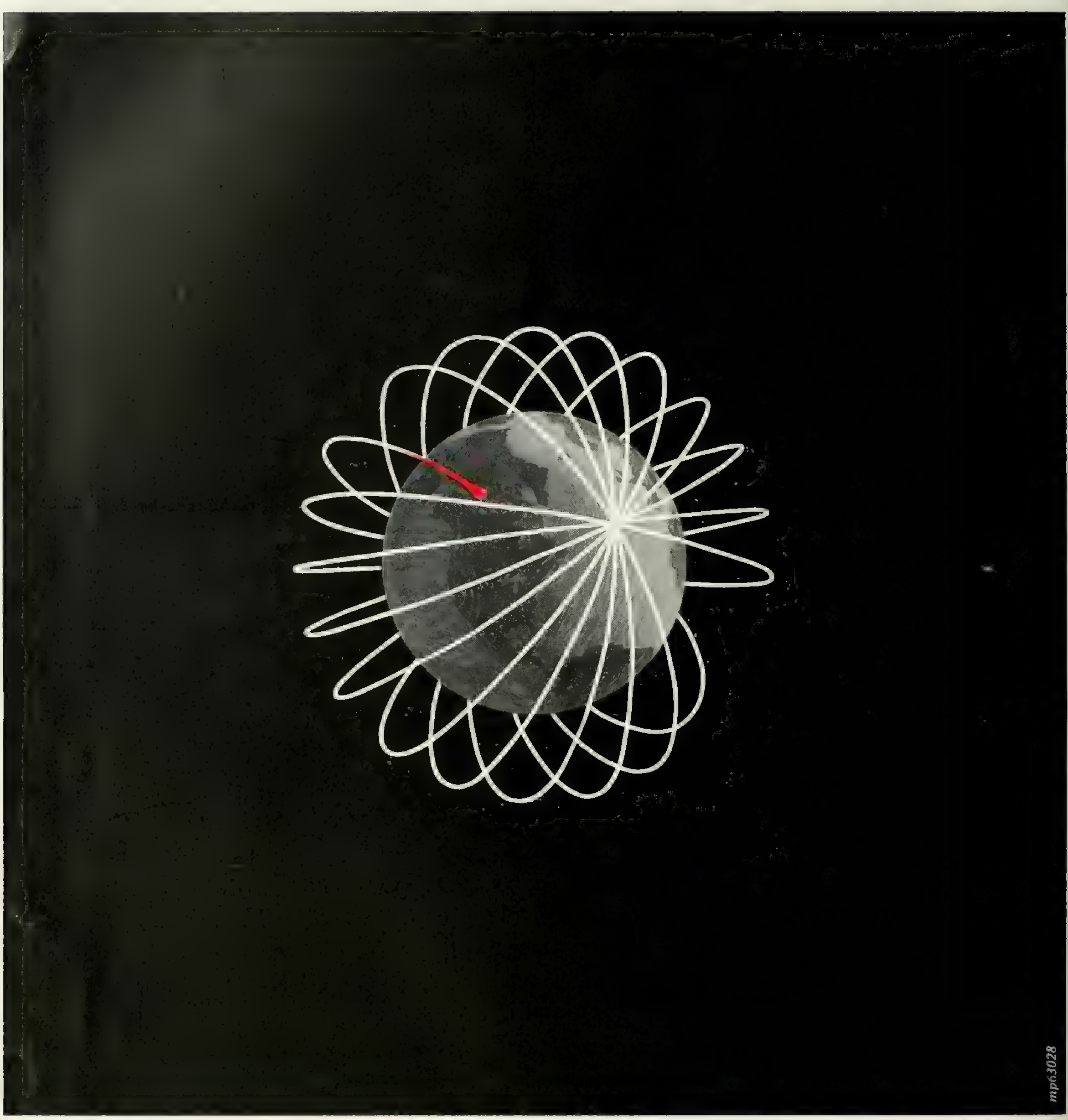

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JULY [illegible], 1963

issiles and rockets

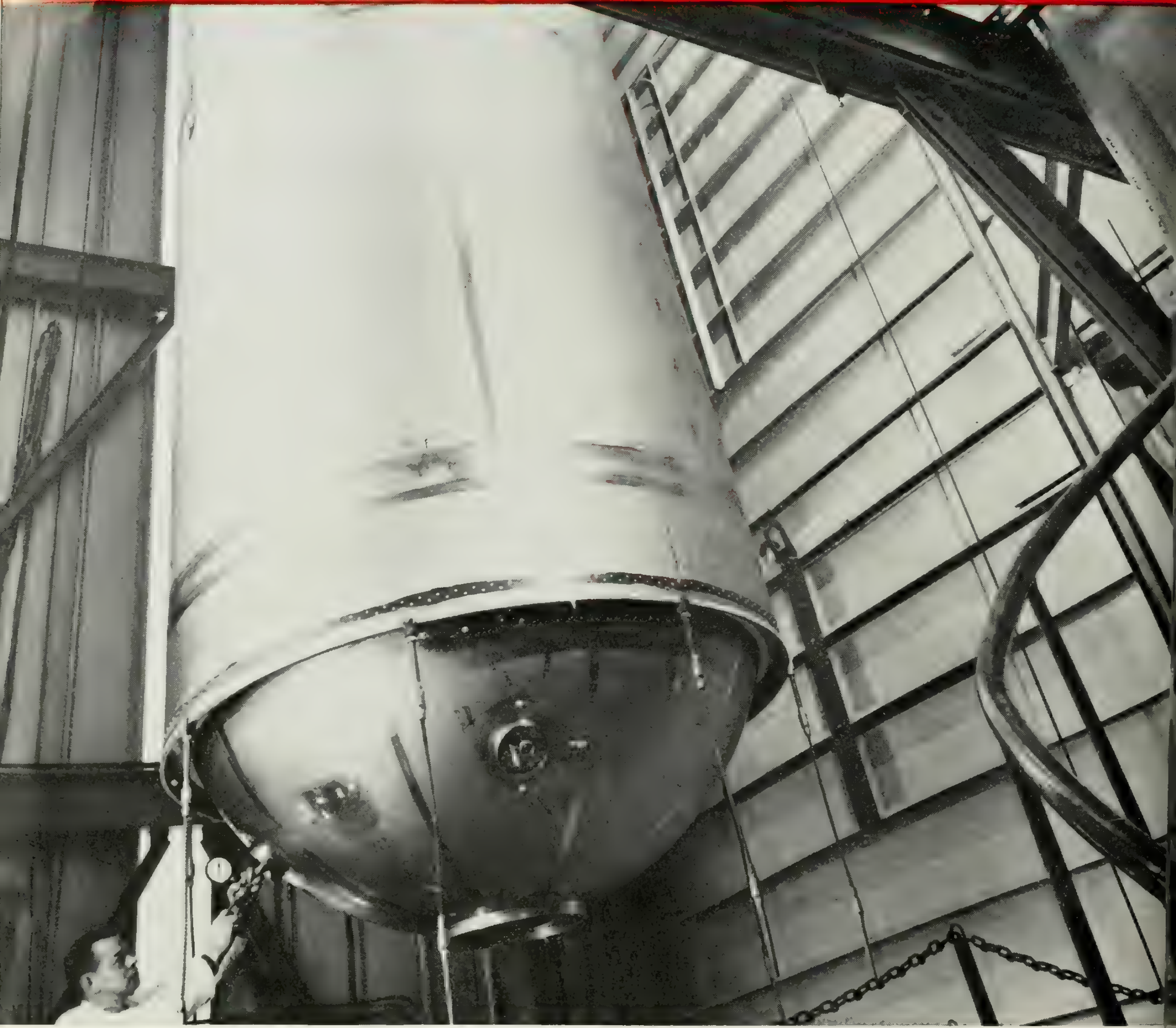
HE WEEKLY OF SPACE SYSTEMS ENGINEERING

AF Recovery Site Plan Finds Foes in Congress

- **Big Solids Funding Trimmed**
- **New Alloy Goes Into Agena**
- **An IMCC Progress Report**

Inflating Echo II's at Lakehurst

Beech *Imaginuity* in FABRICATION . . .



Beech works wonders with titanium to save weight . . . increase space payloads

Largest titanium structure ever built, and Beech built it.

The large tank in this picture is made entirely of titanium. Built by metal-working experts at Beech to hold 7,000 gallons of pressurized liquid hydrogen, the tank is eight feet in diameter and 24 feet long. Weight savings are tremendous.

This means more payload.

Fabricating titanium is an old story at Beech. And if it's something that's never been done before, that's not unusual. In this case the upper and lower hemispherical tank heads were chemically milled in a complex pattern to extremely close tolerances. Production welding of .012″ titanium is S.O.P. at Beech. Much of the equipment used by the Aerospace Division is one-of-a-kind and must be designed and built under the most rigid controls. Other jobs make use of Beech's extensive metal bonding capabilities.

Sophisticated fabrication is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is well prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

Other Beech Capabilities In Systems Management Include:

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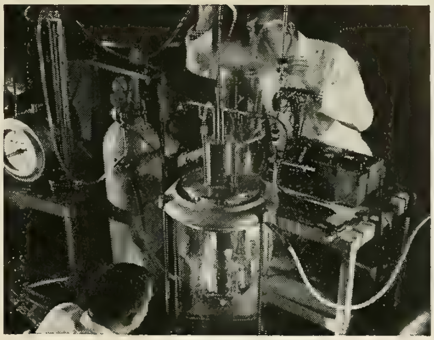
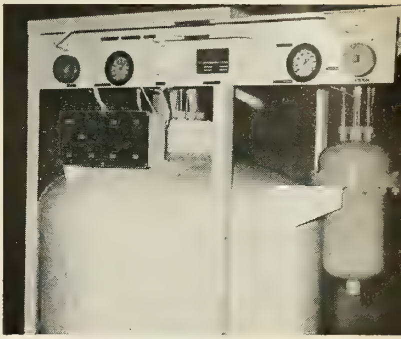


Propulsion . . .



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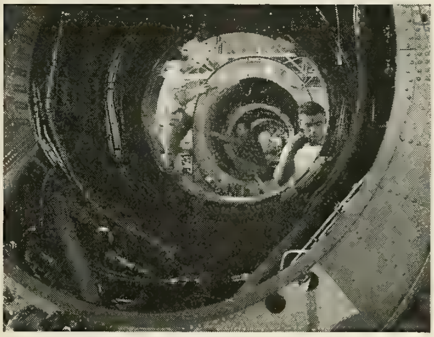

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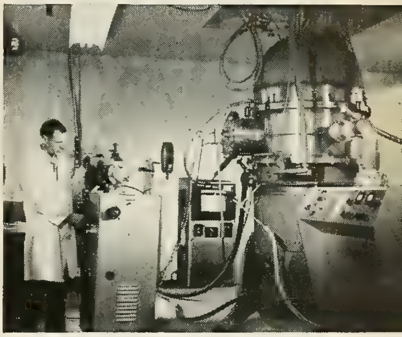
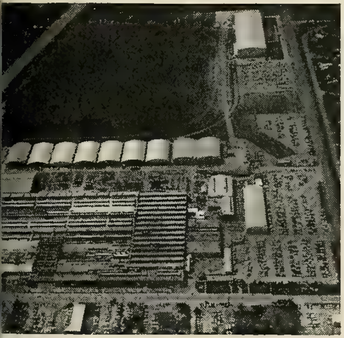


Space Simulation . . .



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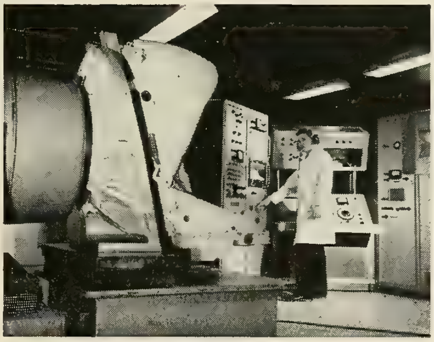

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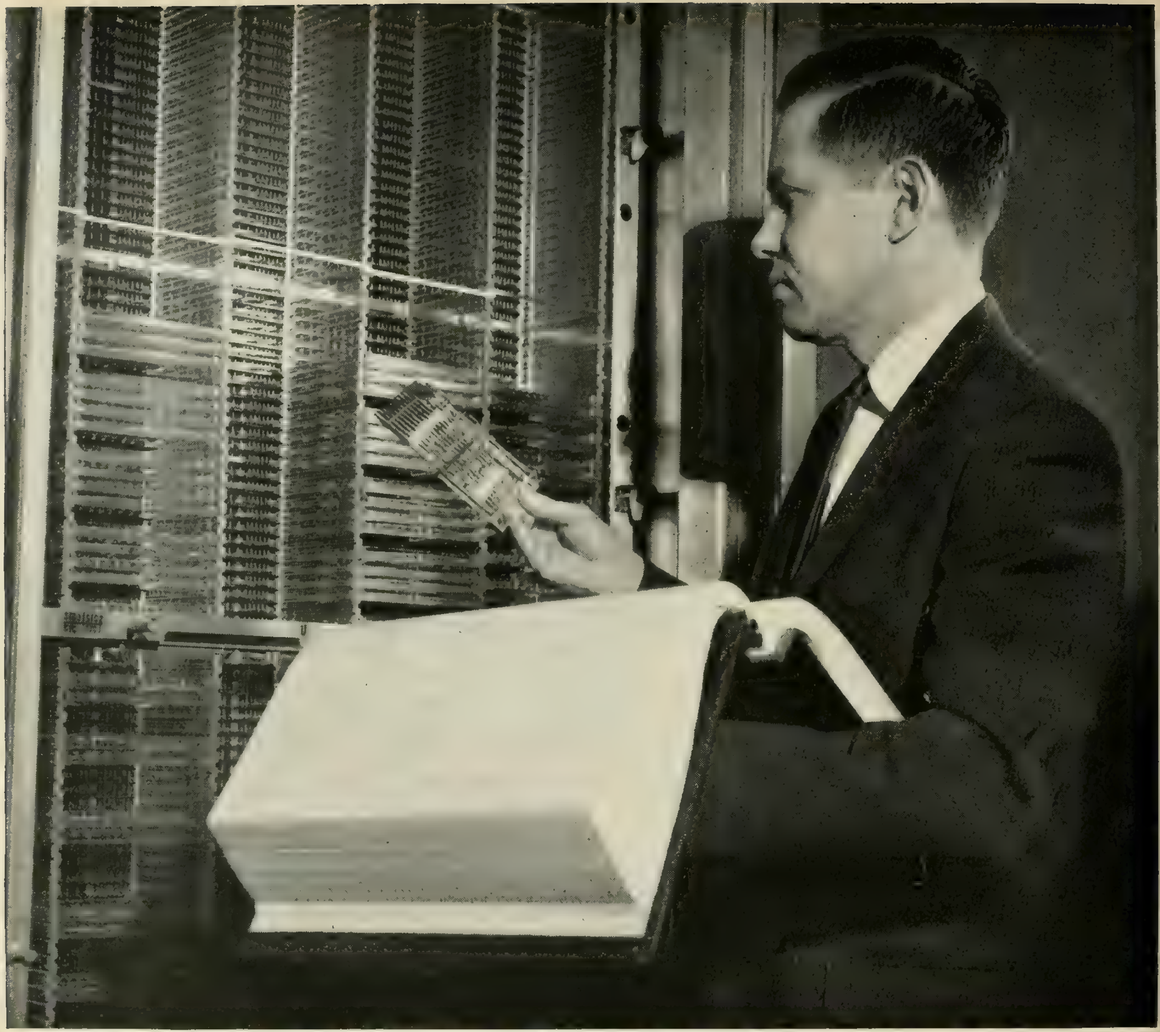

Dictionary refers R. Ketchledge, Director of the Bell System's Electronic Switching Laboratory, to faulty components in a model of the electronic switching system.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 13, Number 2 July 8, 1963

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THE COVER

Partially inflated prototypes of Echo II passive communications satellites take shape at Lakehurst, N. J. The balloons are covered with Alcoa foil/plastic skins. An orbital Echo II launch is scheduled later this year from the Pacific Missile Range.

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SPACE & INFORMATION SYSTEMS DIVISION
North American Aviation

letters

Apollo and Pavlov

To the Editor:

More imagination and enthusiasm has been generated over the *Apollo* program than over anything else since the California gold rush. Recently a pro-*Apollo* letter writer (M/R, June 24, p. 6) suggested that fallout from the $40-billion (*sic*) *Apollo* program could trickle down to the public in the form of better medical instruments, improved electronics, and better pots and pans.

Has it ever occurred to the *Apollo*-philes that there are two space programs—the *Gemini-Titan III* combination and *Dyna-Soar*, that should have priority over *Apollo?* Eventually these two space programs could provide much more national security than *Apollo*—as well as pots and pans.

In a world that is divided into two opposing ideologies and armed camps, it is sheer stupidity for one group, the United States, to place primary emphasis upon exploration of outer space, the Moon and beyond, while the opposing group, the USSR, puts its emphasis on Earth-orbital achievements. Nothing could be more dangerous to freedom and democracy than to have the world watch Russia build military space power while this nation falls into a Pavlovian trap of psychological space accomplishments with no military significance. Our struggle to regain psychological prestige by being first to the Moon is a conditioned reflex to Russia's technical achievements in space. The *Apollo* program should be stretched out and the *Gemini* program should be expanded and accelerated, at least until there is more peace in the world.

LeRoy F. Iverson
Minneapolis

Shrikes No Kin

To the Editor:

Having been a member of the original *Shrike* missile launch crew in 1951, I was somewhat astounded by your article (M/R, May 6, p. 15) on the *Shrike* program.

During the early 1950's the *Shrike* program (GAM 59) was developed by the Bell Aircraft Corp. for the USAF as a prototype for the *Rascal* missile. The *Shrike* program was very remarkable and highly successful, having flight-tested many missile hardware concepts in use today. The *Shrike* program closed out after *Rascal* went into production, but rumors persisted that the *Shrike* plans were being considered for further development by the U.S. Navy.

Did this actually happen? Is the *Shrike* mentioned in your magazine a descendant of the original Bell design?

Eugene C. Sims
Buellton, Calif.

The present Shrike *missile bears no resemblance to the 1951 version used with the* Rascal *program. The Navy says it did not carry the earlier* Shrike *project after the Air Force dropped it. The present* Shrike, *named for the small bird which attacks the eyes of its enemies, is an extremely simple missile, physically resembling* Sparrow III *and containing a radar-homing system to find and destroy enemy radar installations.—Ed.*

Mercury Advocate

To the Editor:

May I welcome Mr. Dandridge M. Cole to the "Hurry-to-Mercury" club? For the past three years I thought I was the only member. Even various journals have stated they were not interested.

Mr. Cole's article (M/R, June 24, p. 34) on Mercury was, however, of far superior quality to any of mine; he is certainly entitled to lead the clan.

I insist that one of the most important reasons for the earliest possible exploration of Mercury (in addition to Mr. Cole's) is the probable existence of vapor strata on its frozen surface by which incidental debris and effects have been sampled, dated, and filed. These strata must occur because of the shock-heating of chilled materials during the periodic advances of the Sun across the so-called "twilight zones," but they may time events even more precisely should the axial tilt of the planet (about 7°) permit progressive deposition continuously around the perimeter of the frigid region.

Mr. Cole's deposits of light elements may in places consist of ultra-thin strata in which are stored the accumulated materials necessary and sufficient for the study and analysis of many solar, cosmic and planetary phenomena as well as relativity effects, the supernova whose only evidence is the white-hot dwarf companion star of Sirius, and others, among which (forgive my probably unjustifiable hope) possible extraterrestrial visitors to the planet, their perhaps still-viable garbage and other refuse, their characteristics and habits, and even the engines, mechanisms, and fuels they used.

Robert P. Kidwell
Flight Simulation Laboratory
White Sands MR, N.M.

Astrolog Reprints

Reprints of Missiles and Rockets' *latest Astrolog, the status report on missiles and space programs appearing in the July 1 issue, may be ordered from:*

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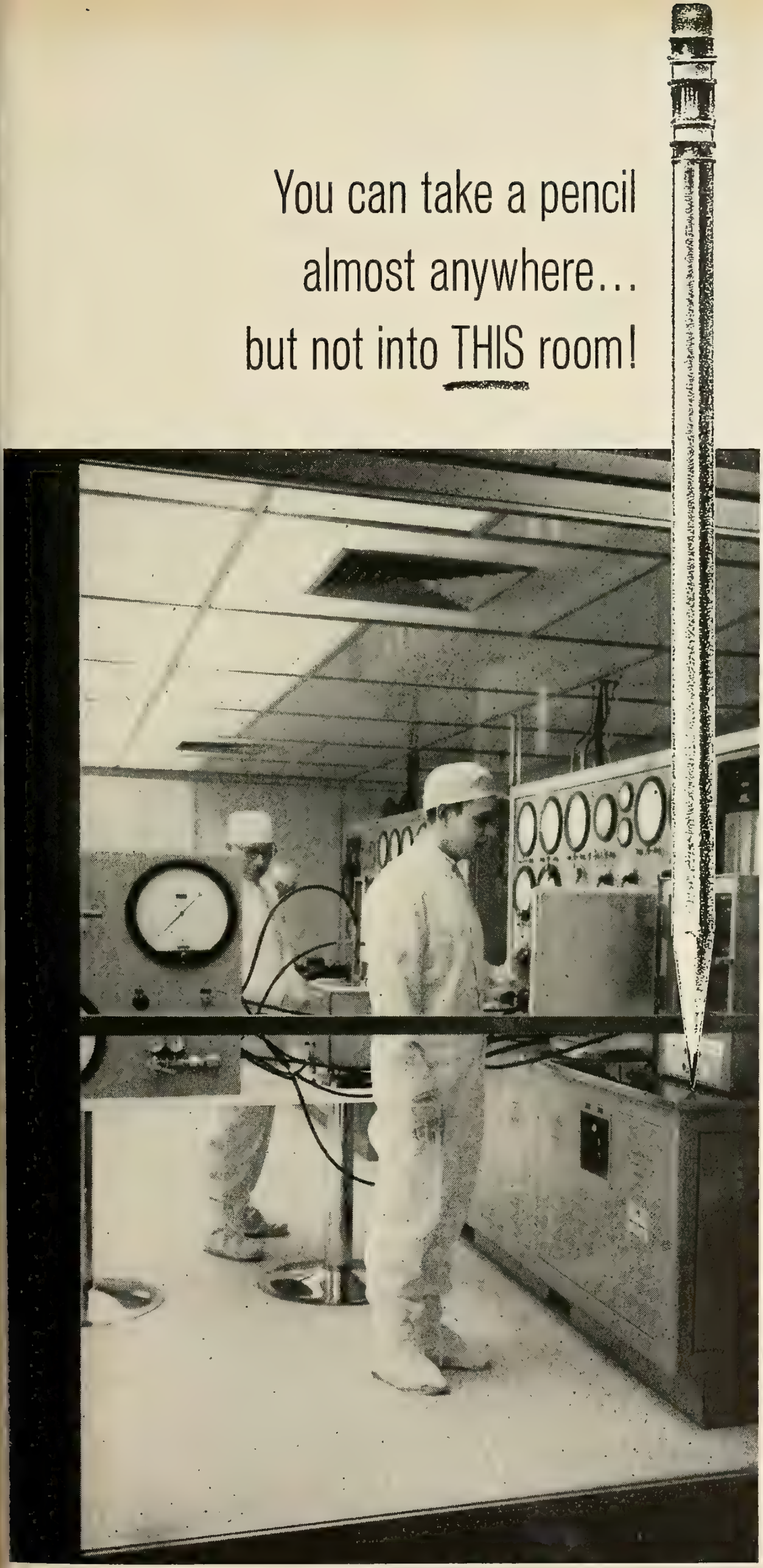

When marking, pencils leave tiny deposits of graphite behind them. Particles of matter even **that** small "matter" in the Chandler Evans clean room facility. They represent contamination.

Similarly, ordinary paper contaminates—hence, paper must be "non lint-producing" or coated with polyethylene film. And even then it is thoroughly vacuum cleaned before accompanying its bearer through an air shower into one of three separate clean rooms. Such are the precautions taken in this unusual "laundry" for space hardware.

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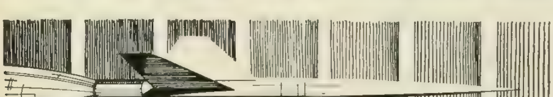

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Planned to operate on the fringes of space, SCAT presents many unique problems. The solutions are doubly important, since they involve factors of practical application to airline operation. Advanced conceptual studies are also being carried on with V/STOL aircraft, hypersonic fighter aircraft and rigid-rotor helicopters.

Projects such as these at Lockheed-California add up to an exciting future—make it yours!

PAPERWORK GETS THE AIR

QUALIFIED SCIENTISTS AND ENGINEERS are invited to investigate immediate openings in: Aerodynamics; Thermodynamics; Dynamics; Astrodynamics; Structural Dynamics; Propulsion; Operations Research (Weapons systems evaluation or cost effectiveness); Human Factors; Reliability; Spacecraft Propulsion (Missiles and Space Vehicles); Controls and Guidance.

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The Countdown

WASHINGTON

Air Force Wants Space Station . . .

Air Force is expected to ask industry this month for proposals on three four-month parallel studies of a *Manned Orbiting Development Station (MODS).* RFP probably will go to about 20 firms. Others wishing to be considered have until July 11 to submit their qualifications to Space Systems Division.

. . . And NASA Wants One, Too

Manned Spacecraft Center at Houston has selected three firms in NASA's continuing *Manned Orbiting Space Station (MOSS)* study program. Lockheed Aircraft was awarded a $300,000 contract for a seven-month study of a large rotating space station and a $100,000 contract for study of a ballistic re-entry logistics craft. Douglas Aircraft received a $150,000 study contract for a large zero-gravity station and Boeing won a $100,000 study of a lifting re-entry logistics spacecraft.

Air Force Gets Sharp

Project Razor's Edge, an effort by the Air Force to sharpen its approach to programs so they will more closely reflect overall Dept. of Defense and Administration objectives, is about to get under way. Top AF generals and planners are due to converge on Washington and Andrews AFB for the project this month.

X-20 Orbital Phase Now Under SSD

Air Force has transferred responsibility for orbital operations of *X-20 Dyna-Soar* vehicles from Aeronautical Systems Division to Space Systems Division. The move, which will not affect air-dropped flights over the Wendover-to-Edwards AFB range, includes assignment of the recovery phase after orbit to the Satellite Test Center at Sunnyvale, Calif. (*see p. 14*).

Rogallo Gliding Out of Gemini Picture?

Top officials now say the Rogallo-wing paraglider for *Gemini* will not be available until after the tenth flight. Since the program as scheduled only calls for 12 flights, it appears certain that any extensive use of the wing will be by the Air Force. With loss of the wing's maneuvering advantage, AF sources say, *Gemini* would have even less promise as a *Dyna-Soar* replacement.

New Versions of Falcon Are Ordered

Air Force has awarded a $25.5-million contract to Hughes Aircraft for two new versions of the *Falcon* air-to-air missile. The nuclear *GAR-11* will be adapted to carry a conventional warhead under the designation *GAR-11A*. Second missile is *GAR-2B*, which will be given increased infrared sensitivity and more versatile capability. Both will be built at Tucson, Ariz.

Fins for Titan III?

Air Force is considering use of fins for *Titan III* in its role as a booster for *Dyna-Soar* manned flights. Fins were slated for use on *Titan II* when it was scheduled as an *X-20* booster. Added stability would ease control problems. Fins would be attached to the two solid-propellant "outboard motors" since they would be unnecessary when the core vehicle was beyond the atmosphere.

NASA Finances NAA Fluorine Study

North American's Rocketdyne Division has won a $138,100 NASA contract for a study aimed at increasing performance of the *Apollo* spacecraft propulsion system with the use of fluorine-based additives. Evaluation will cover increased performance possible by 1970 as well as in the 1970-75 time period. Six best fuel combinations are to be recommended.

Dyna-Soar Definitely Going Up—in Weight

Titan III now is the required vehicle for orbital operations of *Dyna-Soar*. Program officials admit that even *Titan II* has become marginal due to *X-20* weight increases. As first proposed, *Dyna-Soar* could have been orbited by *Titan I*.

INDUSTRY

Hughes Wins Japan Air Defense Award

The hotly-contested competition for a BADGE air defense system for Japan has been won by Hughes Aircraft. Contract value is estimated at $36.1 million. Litton Industries and General Electric were the other competitors.

Lunar Rover Proposals Due August 19

Two or more contractors will be selected for small study contracts on the NASA lunar roving vehicle intended as a future payload for *Surveyor* soft-landing spacecraft. Firms turning up for the bidder's conference at JPL included: AMF, Bendix, Bissett-Berman, Chrysler, Cutler-Hammer, Douglas, Fairchild Stratos, Ford, General Dynamics, General Electric, General Motors, Goodyear Aerospace, Grumman, Lockheed, Marshall Labs, North American, Northrop, Pneumodynamics, RCA, Ryan, Space General, STL, Sperry Rand and Hoffman Electronics. Proposal deadline is August 19.

INTERNATIONAL

Matra to Develop French Anti-Radar Missile

Matra has been selected as the company to manage development of a new French anti-radar missile. The firm also hopes to interest foreign governments in the project, which is supported by the French navy and air force. Matra also has received a contract for development of a missile to analyze radioactive clouds.

Final Agreement Reached on Hawks for Israel

Final approval has been given by both governments for a $25-million sale of U.S. *Hawk* missiles to Israel. Purchase is to counter what Israel calls an ominous build-up of Egyptian airpower.

The Missile/Space Week

Two Get Nuclear Contracts

General Electric Co. and Martin Co. will study the application of nuclear electric power to manned orbiting space stations under terms of two NASA contracts totalling $123,319.

The General Electric award from Lewis Research Center is for $83,228. Martin received $40,091.

GE's nuclear division, Philadelphia, will study reactor heat sources using both thermoelectric and dynamic power conversion systems.

Thermionic conversion will be considered as a potential candidate for later missions. SNAP systems now under development will be carefully studied for adaptability to space stations.

Martin will study isotope heat sources for power conversion at its Baltimore facility.

Two classes of space stations will be considered in the study and design phases of the contracts. The first would support three to six men for one to two years, requiring a two- to five-kilowatt power plant.

This cylindrical station, 32 ft. in dia. and 22 ft. long, would have orbits between 150 and 300 mi. The earliest launch date would be 1967.

The second kind of station would be the rotating (Y) type about 150 ft. in dia. and capable of supporting up to 30 men from one to five years. Twelve to 35 kilowatts of generating capacity would be needed for the station, which could be launched between 1967 and 1969.

Boeing To Study Lunar Base

NASA has selected The Boeing Co. to carry out a four-month study of a lunar base concept under a $196,000 contract.

The study will be the first phase of a broad lunar-base study program to determine if a base should be established on the Moon after the Project *Apollo* manned lunar landing mission is accomplished.

There are no current plans to undertake development of a lunar base.

Boeing was one of 11 aerospace firms that submitted study proposals.

Under the contract being negotiated, the firm will study the general concept of a complete lunar base system consisting of prefabricated modules launched by *Saturn V* rockets. An expandable modular base is considered to be adaptable to both small two-man outposts and larger permanent installations housing up to 18 men.

During the next 18 months, other studies will examine in detail the subsystems and technical and operational problems required for designing a base system to support a number of scientific missions on the lunar surface.

Data from the initial study by Boeing and the specialized studies will be consolidated and a final overall study will provide a comprehensive design of a lunar base.

Beckman Wins TDM Pact

Beckman Instruments, Inc., Fullerton, Calif., has been awarded contracts totalling $2,914,634 to build an equipment network designed to process Time Division Multiplexed (TDM) signals for space programs.

The larger contract—$1,937,134—covers the cost of TDM subsystems. The main facility will be located on Merritt Island, with subsystems at Grand Bahama, Antigua and Ascension Islands, and at Pretoria, South Africa.

Two telemetry formatting systems for reducing telemetry acquired data to a format compatible with computer systems will cost $997,500. The contract also covers digital displays and data-correction equipment.

The pulse-code-modulation, pulse-amplitude-modulation, pulse-duration-modulation and pulse-amplitude and code-modulation telemetry equipment will process up to one million bits of information per second.

A feature of the equipment is a stored program control unit with a high-speed magnetic core memory, which replaces programming patchboards. It will store information of many types and formats, permitting the system to switch data formats without information losses.

Delivery of the equipment is set for January, 1964.

Shots of the Week

Two Air Force Wing II *Minuteman* ICBM's were successfully fired from underground at Cape Canaveral June 27 and July 1.

The latter shot carried an Avco. Corp. Mark 11 re-entry vehicle. The flight marked the first time a *Minuteman* carried a Mistram package, which was tracked actively from Mistram Station 1 at Valkaria, Fla., and passively from Station 2 at Eleuthera Island.

Mistram packages had flown previously on a *Saturn* and several *Titan II* vehicles.

The second launch date coincided with news that the first two flights of the missile had been declared operational at Ellsworth AFB, S. D. Three five-flight Strategic Air Command squadrons will eventually control 150 missiles at sites dispersed throughout southwestern South Dakota.

- Secretary of Defense Robert S. McNamara observed two *Polaris A2* firings July 2 while submerged in the nuclear submarine, Lafayette, near Cape Canaveral. The rockets are said to have impacted 1,500 miles out in the Atlantic Missile Range. Joint Chiefs Chairman Gen. Maxwell D. Taylor and Navy Secretary Fred H. Korth accompanied McNamara.

- Students of the Air Force's Tactical Air Command Training School, Orlando AFB, Fla., successfully launched a Martin *Mace* tactical missile from Cape Canaveral June 27.

- NASA launched an *Argo D4* solid-fueled rocket bearing an instrumented payload from Wallops Island, Va., July 2 to double-check measurements being taken by the U.S.-Canadian satellite, *Alouette*, and to check on its performance. *Alouette* was said to be "doing fine."

- The Army's *Nike-Zeus* performed successfully July 1 in development tests at White Sands Missile Range, N. M. All three stages of the 48-ft. Western Electric-built antimissile missile were fired.

- Air Force Maj. Robert A. Rushworth qualified for astronaut wings June 27 on a 50-mile-high *X-15* mission to acquaint himself with "relatively" high-altitude operations in the NASA rocket plane.

- Two *Thor-Agena*-borne satellites were launched by the Air Force from Vandenberg AFB, Calif., June 26 and 28, respectively. The satellites' type and mission were not disclosed.

Saturn Returns to Marshall

The NASA barge Palaemo arrived at Cape Canaveral June 3 to pick up *Saturn SA-5D* and retur it to Marshall Space Flight Center

The *SA-5D* was used at Cap Canaveral to test propellant-loadin

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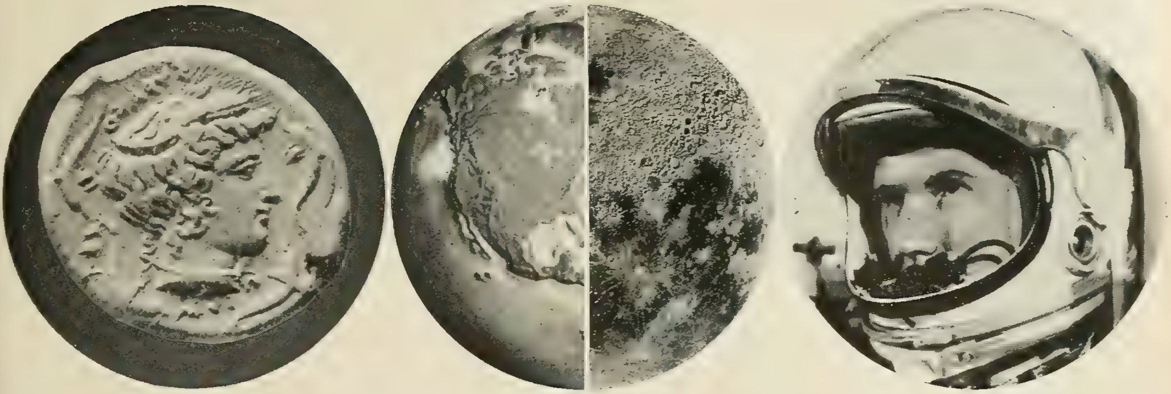

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>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

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systems on Complex 37B where the first Block 2 *Saturn I* will be launched later this year.

At Marshall, the booster will undergo a series of vibration and bending tests of the complete *Saturn I* configuration, which will include the *Apollo* spacecraft command and service modules.

Pan Am Wins Cape Contract

Pan American World Airways, Inc., has been awarded its 11th consecutive contract to operate the Atlantic Missile Range.

The Air Force Missile Test Center contract is for $128,000,000—$18,000,000 more than the cost of last year's operation.

Despite the increase, Pan American will receive $1,750,000 as its fee for operating the range. This is the same fee paid for the past four years.

The contract provides for Pan Am to subcontract some of its technical operations. These include RCA Service Co., $35,000,000; Marine Transport Lines, Inc., $6,500,000; and Cape Canaveral Services Co., $600,000.

RCA handles electronic and optical instrumentation, Marine Transport operates ocean range vessels and Canaveral Services performs marine search, salvage and recovery operations.

Jump Course for Astronauts

American astronauts will begin a parachute training course in late August or early September at Pensacola Naval Air Station.

The jumps will not include free fall jumps such as the Russian cosmonauts use in training for escape and final descent from space flight.

Maj. D. K. Slayton, astronaut coordinator, said the astronauts will make their jumps in connection with two weeks of water-survival training. The astronauts probably will jump from helicopters with parasail parachutes deployed. They will be wearing *Gemini* pressure suits and survival packs.

The exact training schedule depends on arrival of the pressure suits from David B. Clark Co. and completion of the equipment to be used in handling the parachutes aboard helicopters.

Parachute consultant is the Pioneer Parachute Co. of Manchester, Conn., already working with the center on parasails used in model testing and advanced landing systems for spacecraft.

Lunar Scooter Tested

North American Aviation's Space and Information Systems Division has successfully test flown its answer to the problem of finding a taxi on the Moon.

The 20-lb. prototype vehicle is made of aluminum tubing and operates on compressed air jets. It lifted a 210-lb. man and performed horizontal and vertical maneuvers during a demonstration.

Later models of the company-funded, multi-purpose "lunar scooter" will be powered by a rocket motor using storable liquid propellants.

North American officials believe the vehicle may be the answer to astronaut problems of scaling lunar cliffs, traveling cross country and shuttling crew members between orbiting spacecraft.

The ultimate design will call for a small, 10-lb. reaction motor generating 600 lbs. of thrust and providing a speed of 20 mph over a 25-mi. range.

Centaur Shakedown at Lewis

A *Centaur* space vehicle has arrived at the Lewis Research Center to begin a series of environmental tests.

Designated 6A, the *Centaur* vehicle will be installed in the Lewis space power chamber where it will be subjected to simulated conditions of outer space.

All its systems will be operated in the chamber except main propellant flow and engine ignition. These tests will help engineers to determine functional performance, reliability, and life and cycle limits of the various systems.

Although this vehicle is fully flight-equipped, it will never fly. At Cape Canaveral, the *Atlas-Centaur* combination was subjected to prelaunch operation tests on Launch Complex 36A, from where other *Atlas-Centaur* vehicles will be test flown beginning later this year.

Biomed Contract to Republic

Republic Aviation Corp. has received a $100,000 NASA study contract to develop design requirements to ensure human safety and effectiveness on a manned Earth-orbiting space station. The study will also establish criteria for data collection on crewmen's responses to the space environment.

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Congressmen balk . . .

Recovery Site Selection Debated

Senator Anderson, others demand more justification of three-site decision; DOD favors Schriever approach; White House affected

by Frank G. McGuire

A BITTER BATTLE appears to be shaping up over the Air Force's choice of three western U.S. locations for recovery of future manned AF space vehicles (M/R, June 10, p. 34). The dispute, now largely between the Pentagon and the New Mexico Congressional delegation, could reach the White House and affect the degree of support President Kennedy gets from Congress.

The selection of Edwards AFB, Calif., Holloman AFB, N.M., and Wendover AFB, Utah, set off the fireworks by catching both Congressional Space Committees and the interested Congressmen off guard. No one had even told them about the upcoming decision, much less consulted with them. Sen. Clinton Anderson (D-N.M.) was reportedly angered by the selection and as chairman of the Senate Aeronautics and Space Committee he could bring powerful force to bear to have the decision rescinded.

On the House side, the Science and Astronautics Committee is chaired by Rep. George P. Miller (D-Calif.), with Rep. Thomas G. Morris (D-N.M.) also serving on the committee.

• **Who is "Air Force?"**—When Congressmen inquired about the M/R disclosure of the recovery site decision, they were told there had been no such decision. But this denial came from the Defense Department, not the Air Force. It has been learned that AF Systems Command and AF headquarters favor the decision and have officially approved it. However, at the civilian-secretary level within the AF leadership, there is reported to be vaguely defined uncertainty about pouring more money into California as a whole and the Sunnyvale and Edwards complexes specifically.

Despite the shaky nature of some civilian veiwpoints, the Defense Department itself is on record as favoring exactly the Air Force approach. Gen. Bernard A. Schriever, commander of AFSC, is reported to feel that he has made the best possible decision and will stick by it. He has considerable support from the military leadership within the Air Force, but not quite such staunch support from the civilian leaders. However, it appears that the decision has not been countermanded, and may very well become final.

Despite the DOD denial of an "Air Force" decision, it has been learned that a briefing was given to White House officials on AF plans to recover the *X-20 Dyna-Soar* vehicle—using the plan now being disputed.

• **The plan**—Basically, the Air Force plan is to use the landing strips, hangars, instrumentation and other facilities and equipment at Edwards, Holloman and Wendover to recover manned spacecraft. All mission control, including in-orbit operations, re-entry calculations, recovery points and communications will be handled through the AF's existing Satellite Test Center in Sunnyvale, Calif. Data and communications links installed between STC and the bases will transmit necessary information around the network.

In this setup, STC will continue to handle the assignments it has had for several years—that of controlling AF operations in space. Edwards, already handling *X-15* and presumably *X-20* vehicles, will also recover more advanced spacecraft. Wendover and Holloman will act as alternates to Edwards. The three air bases form a triangle covering a large portion of the western United States.

The system is roughly analagous to that used by NASA in its manned spaceflight programs, say Air Force officials. Houston will be the mission control center and the retrieval of spacecraft will be assigned to the Navy. There is no need for a large recovery site, because only routine retrieval of the spacecraft will be necessary.

Only a data link—from a tracking station to Sunnyvale's computers, then to the recovery site—will be needed in order to inform the retrieval force of the exact impact point following retrograde action by the spacecraft.

"Even in the safety-conscious *Mercury* program there was only one tracking ship to verify re-entry and transmit trajectory data," an Air Force spokesman said, adding that "all those other ships were merely to retrieve the capsule and astronaut."

Program officials add that only the initial years of manned spaceflight operations will require "impact point" type recovery. Following the *Gemini*-type vehicles, which will descend ballistically it is expected that maneuverable craf will become standard—in which cas there is a greater argument than eve in favor of runway-equipped recover sites.

• **Eye on potential**—Congressme see it the other way. They feel tha Edwards has had its heyday in the er of the manned airplane and that th AF recovery sites—although simple an economical at first—will eventually become huge facilities including maintenance, refueling, overhaul, trainin and other capabilities. It is these futur "spaceports" that are sought, becaus once located in a selected area, the will expand there and not be move And New Mexico wants even thes initially simple recovery sites withi its borders.

Since both Edwards and Holloma have runways, hangars, and instrume tation available (Holloman is adjace to White Sands Missile Range, one the best-instrumented areas in t world), there is naturally a dispute to the reasons for choosing Edward Air Force officers, testifying befo Congress, have admitted that the Holl man/White Sands complex is well i strumented and has some advantag But they still favor Edwards becau of its experience in handling advanc aerospacecraft.

Sen. Anderson has served notice the Pentagon that he will "seriou question" the decision unless it is justified to Congress on the basis of more-than-marginal economic advantage, and proven that Edwards can furnish facilities and instrumentation superior to those at Holloman/White Sands.

The lack of a clear-cut advantage on all aspects by either of the prime choices lends itself admirably to a political solution.

One protesting Congressman told M/R the Air Force has had its eye on Edwards all along.

"They think they have closed the door on this issue," he said, "but I doubt that they'll get away with it that easily."

Rep. Morris, commenting on the Air Force's logic, questioned the use of Holloman as an alternate to Edwards, where a spacecraft landing short would fall into the ocean. It would seem more sensible to choose Holloman as the prime recovery area, with Edwards as the undershoot-alternative, and a Texas site as an overshoot-alternative, he said.

Obviously, the ground track of the particular orbit being followed by any space vehicle would determine the most advantageous sites for recovery, but most of the interested Congressmen seem to feel Edwards is too close to the coast for secure recovery, and that an undershoot by a spacecraft crew could spell disaster.

- **Sympathy from DOD**—A Defense Department spokesman, caught in the crossfire of pleas for support from the Air Force and blasts of criticism from Congress, offered AF planners some sympathy.

"I would say they made this decision in a purely routine way after studying the best way to tackle the problem, and didn't realize how controversial it was nor how many political irons were in this particular fire," he said. "It is true that we go along with the Air Force approach to this situation," he added, "and if our studies are any indication of the facilities required, there will be more newsmen than instrumentation operators at the landing site."

Countering this estimate of the installation's size, a Congressman acidly commented:

"They're trying to tell us that all they'll need is a truck to cart this thing back to an airport for shipment to someplace, but the Air Force's own history belies that possibility. They haven't started out on one of these 'poor man's do-it-yourself' kits yet that didn't cost a few hundred percent more than they told Congress it would cost." ■

Sunnyvale Center Preparing for Dyna-Soar Control Assignment

by Robert Lindsey

SUNNYVALE, CALIF.—A 10-member Space Systems Division team is scheduled to recommend a flight test plan this month for *X-20 (Dyna-Soar)* missions utilizing the Air Force Satellite Test Center here as Mission Control Center.

Air Force sources told MISSILES AND ROCKETS last week that only relatively minor changes will be necessary to adapt the STC for *X-20* missions. Principal revisions will be addition of systems for receipt, analysis and display of data on life support systems in the X-20 and physiology of the astronaut.

Data links must be provided to the three selected recovery areas—Edwards AFB, Calif., the primary retrieval site, and back-up sites Holloman AFB, N.M., and Wendover AFB, Utah—and any tracking stations participating in the tests. (Selection of the three sites and the Air Force decision to utilize the Sunnyvale complex as mission control center for the *X-20* flights was revealed exclusively by M/R, June 10, p. 34.)

The choice was made after a series of studies which convinced Air Force planners that the existing facility here could handle the command and control role in *Dyna-Soar* and other manned programs without major changes or expenditure.

- **Minor changes**—As now envisaged, the control room used to direct flights of *Discoverer, Samos, Midas* and other USAF unmanned satellites will be utilized with minor changes to provide decision-makers with spacecraft environmental data and other information peculiar to the *Dyna-Soar* mission.

Unlike NASA's Integrated Mission Control Center at Houston, the STC will utilize the main control room, rather than a separate rehearsal center, for mission rehearsals.

Present computer ability is considered more than adequate for the new mission. "We see practically no major cost in adapting to the *X-20* programs . . . maybe we'll have to add about 30 persons," one Air Force source said.

Controlling the *X-20* flights in addition to the STC's already heavy load, he said, will be primarily a "matter of scheduling." When *Dyna-Soar* missions are programmed, other operations will be slackened.

- **In abeyance**—Several aspects of the program are unresolved, including the question of whether the Atlantic and Pacific Missile Ranges will handle the tracking or whether tracking stations will come under jurisdiction of the 6594th Aerospace Test Wing, which operates the STC and its own network of stations in Alaska, Hawaii, New Hampshire, Vandenberg AFB, Calif., and possibly other undisclosed sites.

The sentiment here is that the Test Wing should operate any tracking facilities added to its network for the *X-20* shots. "They'll almost have to be ours," one wing officer said. "From past experience we've found we have to have control if we're to get the tracking data we need in a real-time operation."

Also undecided is whether an *X-20* simulator will be located here for rehearsal of missions. If not, it would probably be located at Edwards or Cape Canaveral and data links would be provided to the STC.

The SSD study, originally due July 1 but reportedly two weeks or so behind schedule, is aimed at establishing a framework of data for the *X-20* orbital and suborbital tests from which precise test plans can be made.

- **Growing pains**—The STC, established four years ago for R&D flights in the W117L program, has evolved into a multipurpose command post for space missions. The 6594th operates the facility as a host organization offering a service to agencies conducting experiments. Since its inception the facility has controlled more than 70 satellites and issued more than 100,000 ground-space commands.

Initially, the control center could handle only a single mission at once, but its capability has increased; now it can handle three relatively complex missions at a time and up to 10 or 12 if the satellites do not require extensive control operations.

Located on government property adjacent to the Lockheed Missiles & Space Co. main plant here, the STC has 500 military and about an equal number of contractor personnel.

Despite a $500,000, L-shaped addition to the facility last year, the STC is overcrowded and the Air Force is leasing trailers to take care of overflow. A second L-shaped wing is proposed in the new budget. ■

Down to $16 million . . .

DOD Ponders New Cut in Solid Funds

Administration says two-year delay might result; industry spokesmen say further slash could be fatal

by Hal Taylor

THE DEFENSE DEPT. is considering a sharp cutback in Fiscal 1964 funding of the Air Force big solid motor development program—a move which could all but destroy it.

The slash, Administration officials say, would reduce funding from $46 to only $16 million.

Coupled with the program's Fiscal '63 experience, approval of the latest cutback would mean that some 50% of its authorized funding has been taken away in its first two years of existence.

In Fiscal '63, DOD reprogrammed $11 million of the $25-million appropriation for big solid development to other projects. It promised the funds would be returned in Fiscal '64.

A further slash would clearly mean that the target date of a firing of a full-length 260-in. motor in May, 1966, is out of the question. A delay of two years would become likely, Administration officials said.

Industry sources were more pessimistic and vehement. "Even with full funding the program was marginal. This latest cut could kill it," one declared.

The Fiscal '64 reduction apparently is being considered by the Office of the Director of Defense Research & Engineering (DDR&E) because it sees no mission for the big solid-propulsion vehicles.

Both the Air Force and NASA—which ultimately might use the motors in post-*Advanced Saturn* launch vehicles—have opposed the cut with little success.

• **Something must give**—The recommendation was made as DOD officials scurried around in the wake of the House of Representatives' approval of a $2-billion slash in the department's $49-billion Fiscal '64 appropriations bill (M/R, July 1, p. 17).

DDR&E quickly determined that one of the programs which would have to share in the budget reduction was big solids—even though contracts with the four firms involved in the program were signed only in the last two weeks.

The decision apparently is not final simply because DOD officials have hopes of getting Congress to restore some of appropriations reduction.

They point out that Secretary McNamara will testify before the Senate Armed Services Appropriations Subcommittee and file what is called a "reclaimer".

Even if he is completely successful—which appears unlikely—and the Senate votes to restore the entire $2 billion, the bill would then have to go to a joint House-Senate conference committee.

Members of the House of Representatives, which voted 410 to 1 for the cut, certainly would not go along with complete restoration. A compromise settlement is certain. Thus, the best that DOD can expect is that the two houses of Congress will split the difference and approve a final appropriations bill of about $48 billion.

Considering DOD's past approach to the big solid program, it is not likely that a $1-billion restoration would result in any great reduction in the planned cut in the program's funding.

Outlook Better for Flight Research Center

THE CHANCES for continuation of NASA's Flight Research Center improved considerably last week when a top space agency official revealed that one new aeronautical research program is in the planning stage.

Dr. Raymond L. Bisplinghoff, Director of the Office of Advanced Research & Technology, told MISSILES AND ROCKETS that while program approval has not yet been obtained, NASA plans to modify the No. 2 *X-15* plane in order to test an air-breathing propulsion system.

He also said that it is not inconceivable that the space agency eventually will have another research plane to study technology in the hypersonic Mach 10 range.

At the same time, a leading Democrat on the House Space Committee declared that if the space agency does come up with new flight research programs, the committee will reconsider its recent recommendation that the Flight Research Center at Edwards AFB, Calif., be closed with the termination of the *X-15* program in Fiscal 1965.

Rep. Joseph E. Karth, (D-Minn.) chairman of the Space Sciences subcommittee, which made the recommendation, said, however, that "at this time I have heard of no such (new program) plans."

The recommendation was included in the subcommittee's report on the Fiscal '64 budget request of the Office of Advanced Research and Technology. Final action on the budget and the recommendation has been delayed until July 8.

Bisplinghoff admitted that no new flight programs have been approved by top space agency officials.

• **X-15 and beyond?**—"We do feel that the Center will play an important role in our aeronautical research program," he added. "Even after the *X-15* program is phased out, we will have aeronautical as well as space-oriented program which will use the Center."

He said that modification of the *X-15* would enable the space agency to test air-breathing propulsion plants attached underneath the plane. He said the project might begin in Fiscal '65, and would add about another year to the *X-15* program.

Marquardt Corp. was recently awarded a four-month study contract to determine if the project is feasible.

As far as NASA's work on *Dyna-Soar* is concerned, he said that data reduction will be handled at the center. He admitted that this work could be transferred to another space agency facility. As for the future, he said he did not think that NASA would play a major role in the Air Force program.

- **Hard row**—The Fiscal '63 budget reduction from $25 million to $14 million is one example of the DOD disenchantment with the program which has been evident since it was first proposed by President Kennedy in May, 1961.

Originally, the big solid motors were to be developed as a backup to NASA's *Nova* launch vehicle for the planned direct flight to the Moon with the *Apollo* spacecraft.

NASA was to approve the specifications and the Air Force was to fund and develop the motors.

In 1962, NASA scrapped the direct flight method and instead decided to use orbital rendezvous and the *Advanced Saturn* booster for project *Apollo*. As a result, a decision was made to delay the *Nova* booster.

NASA and the Air Force, however, proposed that deveopment of the big solid boosters continue—although at a slower pace.

DOD balked at the large funds which a development program would entail. After six long months of negotiations it finally agreed to what it called a "feasibility demonstration" program.

The four-phase program was initiated in April, 1963, with the selection of three contractors—Thiokol Chemical Corp., Aerojet-General Corp. and Lockheed Propulsion Co.

The plan included:

Phase 1: Demonstration static-firing of a 260-in. solid rocket, half-length, of approximately 3 million lbs. of thrust. One such motor is to be fired by Aerojet-General and another by Thiokol.

Phase 2: Demonstration static-firing of a 156-in.-dia., 3 million-lb.-thrust solid with movable nozzle. This motor will be built and fired by Thiokol.

Phase 3: Static firing of a 156-in.-dia., 1-million-lb.-thrust, single-segment, solid rocket using movable nozzles for thrust vector control. This will be handled by Thiokol Chemical Corp.

Phase 4: Static firings of 156-in-dia., 1-million-lb.-thrust, single-segment, solid rockets using jet tabs for thrust vector control. This assignment goes to Lockheed Propulsion Co.

The authorized program runs into 1966. The schedule calls for the first firing of a 156-in. nozzle in November, 1963, two more firings of 156-in. motors in May or June, 1964, first firing of a half-length 260-in. motor in October, 1964, by each of the two contractors, and another firing of a half-length 260-in. motor by each contractor in May, 1965. At that point, if the program feasibility has been proved, a single prime contract will be selected. Firing of the first full-length 260-in. motor would come in May, 1966.

If the proposed $30-million reduction in Fiscal '64 is approved, the schedule would be considerably stretched out.

Since contracts with the three firms were signed only in the last three weeks, the companies are just at the point of beginning serious work.

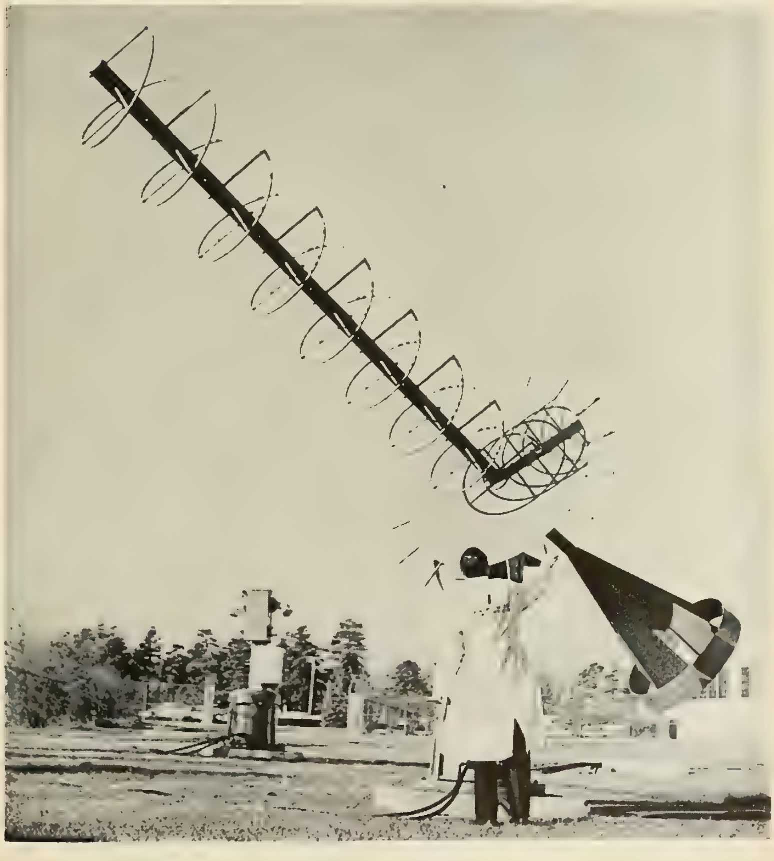
Industry sources report that work on the 260-in. motors would be most affected—primarily because it is the portion with the highest cost.

- **Where it hurts**—The funding slash will be a heavy blow to both Thiokol and Aerojet, since corporate capital has been plowed into the acquisition and development of huge processing plants near navigable waters.

While there was never any provision for facilities in the funds slated for the development of the large solids both firms have allocated more than $10 million apiece in facilities—Thiokol at its Camden, Ga., site and Aerojet in Dade County, Fla.

It is a hard economic fact that any return on these investments would have to come from follow-on programs far beyond the current one and spokesmen for both firms have stated this in the past. Both firms, together with Lockheed Propulsion, moved ahead with facilities long before the specific contract awards and with full knowledge of the no-facilities-included in the proposed Program 623A. Yet both industry and government agree that the program could not be carried out without such new facilities.

Another problem raised by the proposed funding cut lies in the nozzle area. A crucial section of the large solid program is aimed at the development of large nozzles, their production processes and the associated thrust vector control. All these sub-programs would suffer as much as the primary one. ■



Fairchild's Nimbus Photo Receiver

LOW-COST WEATHER stations around the Earth will use this broadband helical antenna to receive cloud-cover pictures from the RCA-developed Automatic Picture Transmission Subsystem carried in future Nimbus *satellites. Developed by Fairchild Stratos Corp. under contracts totalling $2 million for Goddard Space Flight Center, the ground stations will be tested with* Tiros VIII, *scheduled for launch in September. Fifty-one of the small stations have been ordered for use by NASA (7), Air Force (20), Weather Bureau (11), Navy (6), Army (1), and foreign governments (6). (See also M/R, Dec. 24, p. 24).*

Low-cost re-entry study . . .

First Athena May Be Fired in August

THE AIR FORCE is aiming for an initial launch in late August in its $40-million *Athena* advanced re-entry research and development program.

The project is intended to be a relatively inexpensive effort utilizing off-the-shelf missile hardware to artificially create ICBM re-entry conditions. It will call for launching four-stage solid-propellant vehicles carrying subscale re-entry bodies.

Athena will obviate the use of expensive ICBM boosters. It will achieve ICBM re-entry speeds by shooting payloads back down into the atmosphere from apogees of 50 to 200 mi. at varying velocities. *Athena* launches will be made from a new Green River, Utah, site, and impact will be at White Sands, N.M., some 420 mi. away.

Lt. Col. Richard Parker, program director under Col. D. C. Middlekauff, deputy for ballistic re-entry systems, Ballistic Systems Division, told Missiles and Rockets the program is expected to produce hardware directly applicable to weapon systems.

- **Breakthrough sought**—One aim of the project is research leading toward development of practical means to communicate through the re-entry plasma sheath. For some special purposes in the past, transmission has been achieved through the sheath by reducing the sheath to a minimum. *Athena* will seek to broaden this application, studying the rate of formation of the sheath, its rate of decay, and the strength of the ionized layer as a function of time, velocity and altitude. It seems possible *Athena* could achieve a breakthrough by employing sheer transmission power or proper shaping of the re-entry body.

Athena is not yet concentrating on any one ICBM problem. Parker says "our purpose is to obtain a better understanding of the entire re-entry phenomenon and apply this directly to development of re-entry vehicles and systems for the ICBM force. We're looking at all factors involved—vehicle shape, speed, materials."

- **Specifics**—The program, to run about two years, has so far scheduled investment of about $10 million in rocket motors. First stage of the *Athena* vehicle consists of an XM-33 Castor motor and two XM-19 Recruit motors. Second stage will use one of two available motors, depending on the trajectory desired—either an X-259 or a 261 motor. Third stage is equipped with a 30KS 8000 motor. A BE-3 powers the fourth stage.

The missile is 50 ft. in overall length and weighs 16,000 lbs. at launch. First two stages are fin-stabilized. Missiles takeoff from a zero-length launcher on a ballistic trajectory and enter guidance phase when altitude is reached, at which point the rocket is aimed at the White Sands impact point and the third stage is fired.

Because of the overflight problem, the third stage isn't fired "until we make sure it's going where it's supposed to," a spokesman said. If the third stage isn't fired, it will impact harmlessly with the second stage. The range safety system at Green River will have destruct capability through first- and second-stage burn. Third and fourth stage firing provides desired re-entry velocity.

Athena will fly re-entry angles of 20 to 45 degrees. Re-entry speeds will vary from 16,000 to 23,000 fps or less depending on payload weight, which ranges from 300 lbs. down to 50 lbs. or less. Design point was 50 lbs. Payloads, which will involve no detonations or warhead configurations, are classified. Some will carry virtually no instrumentation.

Although *Athena* is regarded as an in-house BSD project directly supporting the weapon system effort, other organizations have become interested, and BSD expects to fly payloads for other Air Force groups as well as other services. BSD is working closely with ARPA in the latter's extensive re-entry flights from Green River, including a number for BSD.

BSD's *Athena* research is concerned exclusively with offensive applications. "Part of the ICBM problem lies in the fact that defense against ICBM's is possible and probable," the Air Force said. "We want to improve the product, make it harder to defend against."

But the division expects its work will develop information useful to other agencies investigating the defensive area, and is working closely with those who are "interested in what the future defensive systems might be".

- **ARC prime**—Choice of the missile and flight envelope were major factors in selection of the launch site. Prime contractor is Atlantic Research Corp., which has leased a Union Carbide plant at Green River. Formerly a uranium ore processing mill, the installation has been refurbished and modified for use as an *Athena* missile assembly plant. ■

RCA Wins LEM Electronics Subcontract

RCA HAS BEEN AWARDED an estimated $50-million contract for electronic subsystems and engineering support for the Lunar Excursion Module (LEM) of the *Apollo* spacecraft.

The selection of RCA was announced by Grumman Aircraft Engineering Corp., prime contractor for the LEM spacecraft. The firm will have responsibility for five basic LEM subsystem areas: systems engineering support, communications systems, radar systems, in-flight test systems, and ground support equipment for certain subsystems to be supplied by the firm. In addition, RCA will fabricate selected electronics components of the stabilization and control system.

Most of the work will be performed at the company's Aerospace Communications and Controls Division, Burlington, Mass., under direction of the prime contractor.

Although RCA will provide system engineering for certain LEM electronic systems, substantial manufacturing will be subcontracted by RCA. In particular the use of common *Apollo* and *Gemini* spacecraft parts will be implemented under the RCA make-or-buy plan, which is subject to the approval of Grumman and NASA. Other specialized equipment will be subcontracted in a similar manner.

The five other major subcontractors to Grumman are: Rocketdyne Division of North American Aviation, Inc., lunar descent engine; Space Technology Laboratories, parallel development of lunar descent engine; Bell Aerospace Corp., division of Textron, ascent engine; Marquardt Corporation, reaction control system; Hamilton Standard division of United Aircraft, environmental control system equipment.

Astronauts May Become 'Artists'

Crayons considered for Gemini pilots since films have failed to record some phenomena accurately

by Russell Hawkes

GEMINI ASTRONAUTS may rry crayons to record the colors and etails seen from space. Such a plan is nder study by Astronaut Walter M. chirra and a group at the NASA Manned Spacecraft center.

Schirra told MISSILES AND ROCKETS hat the best films and hand-held cameras have consistently failed to record recisely some unexpected things seen rom orbit. There have been similar ailures in the fields of astronomy and microscopy; in some of these cases rtist-experts were pressed into service nd successfully recorded what they aw.

Schirra links these facts to the controversy over whether one of his colleagues, Gordon Cooper, actually saw buildings and smoke on the Himalayan Plateau or whether they were hallucinations. Some experts on the human optical system contend that the objects were beyond the limit of resolution of his eye. Therefore, they say, any objects of that size which he reported had to be hallucinations.

An opposing school of thought, while conceding that there is a shortage of supporting experimental evidence for their view, argues that an unknown neurological process permits a living man to perform better than the science of optics would indicate. Schirra's study and the experiences in astronomy and microscopy form a rallying point for supporters of this view.

Some scientists, unwilling to venture a hypothesis, merely argue that it was "presumptuous" of Dr. W. Ross Adey of the UCLA Brain Research Institute to advance the hallucination explanation in view of Cooper's perfect performance of his mission.

Dr. Duane Catterson, of NASA Manned Spacecraft Center, told M/R that "Too little is known about the fundamental physiology of vision to permit flat statements of this sort."

The whole question seems headed for a place high on the list of things to do in the *Gemini* program. Dr. Adey hopes electroencephalographs in the spacecraft will yield further information. Sarcastic critics predict that the EEG will prove only whether the astronauts are awake or asleep—that other readings will be subject to too many differing interpretations.

NASA has thought of placing eye-test patterns in areas of consistent visibility, such as the New Mexico desert, but a firm decision to make the experiment is not thought to be imminent. The agency was frustrated in its project *Mercury* night flare visibility experiments by cloud cover, and some sort of visibility experiment is thought to be necessary. Scientists will be more careful about choosing clear-weather sites in the future.

- **Art subjects**—Among the things Schirra would like to paint on *Gemini* flights are these:

—The color-change of planets, especially Venus, as they sink through the bands of light at the horizon. Astronauts report that the best color films of this event taken from space are inaccurate.

—Moonset. Schirra saw a halo about the Moon as it passed through the horizon and took what he thought would be an excellent photo. However, the films revealed nothing of the halo.

—The so-called "Red Arcs," an ionization phenomenon that occurs at an altitude of about 150 miles. They cannot be photographed, but an accurate representation of them might help atmosphere physicists learn more about the energy process that creates them. Schirra says they have exactly the color and texture of Los Angeles smog as seen by a pilot at night, but this is not a very meaningful explanation to most physicists.

—Details upon the ground, perhaps checked by simultaneous photographs. Often overlooked in discussion of Cooper's hallucinations-or-aren't-they is the fact that Schirra reported seeing the wake of a water skier on the Salton Sea and John Glenn saw dirt roads in Mexico. These are similar in size to what Cooper reported. On-the-spot representations might help unravel the controversy or explain the physiological process.

Typical of the accomplishments of artist-experts in astronomy are the paintings of Mars by Dr. G. De Vaucouleurs of the University of Texas. He is regarded as one of the foremost students of the planet and his paintings are praised by fellow astronomers for their accuracy, detail, and color, though explanations of what the trained astronomer sees are still controversial.

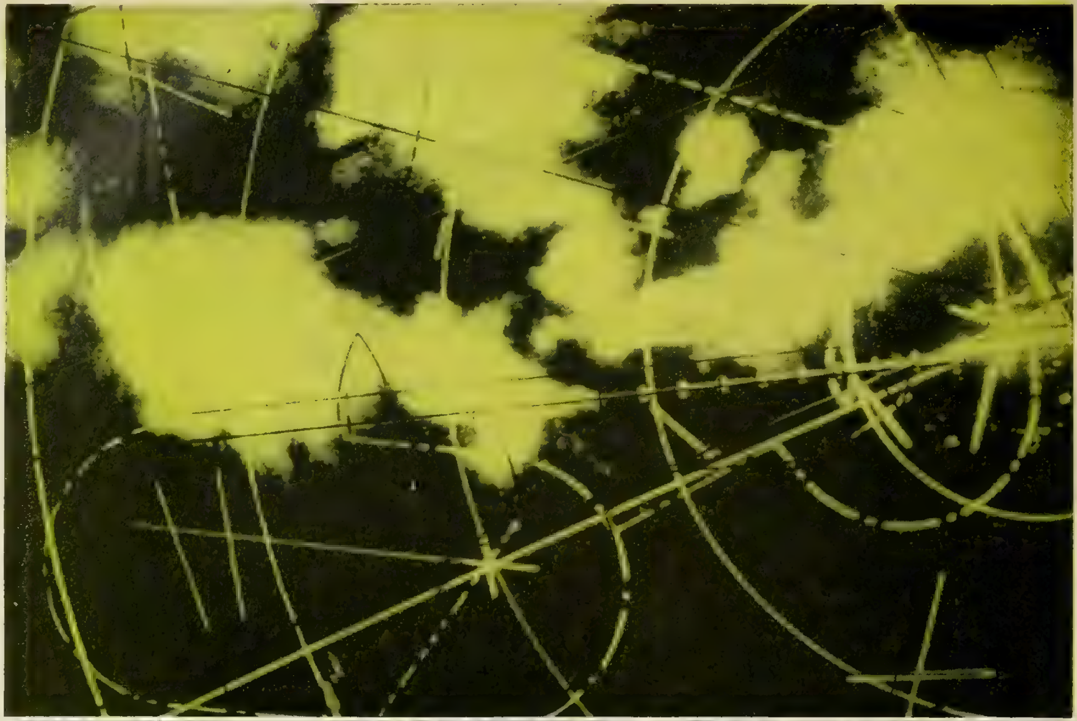
The untrained eye and the best of cameras detect little of what De Vaucouleurs has drawn. The role of professional training may be vital in the physiology of vision. The scornful phrase "Sloppy Seeing" has long been in use by astronomers and indicates that "good seeing" is a professional skill.

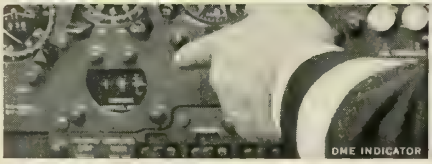
- **Problem of medium**—Artist-astronauts face new technical problems. Schirra was introduced to drawing and painting as a hobby years ago by his mother, and he has attempted to envision the difficulties.

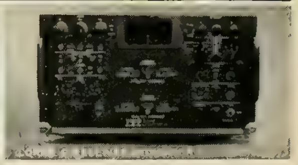
Oil paints give the most vivid interpretation of colors, but seem to be out of the question for space. It would be difficult to keep the paint on brush or palette in a weightless environment, and flying paint drops could be more than a nuisance. Also, in the absence of gravity, surface tension becomes a more potent force and the manner in which paint is transferred from brush to canvas or paper may be changed.

Crayons look like a better bet. Schirra has bought commercially available crayons and discovered that one manufacturer offers a range of about 100 colors. Colored chalk is also being considered.

Whatever is selected must be compatible with the pure-oxygen atmosphere of the spacecraft and exposed components. If the idea of astronaut-artists is pursued, it may become necessary to take a second look at cabin lighting to avoid color errors that have been made in some underwater drawing attempts. ■







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Technical Countdown

ASTRONAUTICS

High-Altitude CryoPump Techniques Studied

A laboratory wind tunnel to test the feasibility of using cryogenic pumping for boundary layer control in near-orbital altitudes has achieved early success in tests by General Dynamics/Astronautics. The concept is based on an ultra-low-density parallel to suction pumping of the boundary layer now being tested in Northrop's Laminar Flow Control *X-21* program. In cryopumping, the bottom layers of air molecules adhere to a cold surface and are condensed out of the flow. Mechanical pumping is impossible at such low densities. The GD/A tunnel operates at mach-7 with a tunnel atmosphere pressure laminarized by reducing the surface temperature of the 8.8-in. test-section inlet nozzle to about 77°K. The hollow nozzle is filled with liquid nitrogen. Applications for boundary layer cryopumping are not defined, but since GD/A has one of the three *Aerospace Plane* study contracts, the research may supply information about the use of liquid hydrogen fuel to cryopump oxygen out of rarified air.

ELECTRONICS

Martin Wins Big IR Sensor Contract

An $827,000 NASA contract for advanced infrared sensors was awarded last week to Martin Co.'s Electronic Systems & Products Div., Baltimore. The unusually large contract calls for both production of conventional IR sensors and for development of a number of advanced horizon sensors. All will be used in the *Saturn* program. Advanced versions, however, will be employed on *Saturn* flights in 1965-1966. Operational sensors, according to Martin, will determine vehicle attitude to within six minutes angular accuracy and will have a minimum operating life of three months. Four mutually perpendicular sensing heads, each scanning a 90-degree vertical sector, will be used in the horizon-sensor devices.

1,500-Joule Laser Developed

At roughly $50,000 each, a new ruby laser having a guaranteed power output of 1,500 joules per pulse is available from Maser Optics, Inc. Developed on company funds by the Boston firm, it is believed to be the highest power ruby laser obtainable commercially. The device requires approximately 120,000 joules/pulse input, developers disclosed.

ONR Orders New Research Dish

A 60-ft.-dia. Cassegrain antenna will be built by Aeronca Mfg. Corp. for Navy space communications and satellite tracking research. The recent Office of Naval Research Contract, totalling nearly $1.85 million, calls for completion and installation in about one year at a Waldorf, Md., site. The big dish will be fabricated of aluminum-honeycomb sandwich, the company said.

ADVANCED MATERIALS

Russians Study Radiation Resistant Glasses

A group of foam glasses, currently being studied by Soviet scientists, exhibit excellent radiation and temperature-resistance characteristics, according to a recent report in the British newspaper *Electronics Weekly*. Alkali window glass containing titanium and zirconium dioxide, and also barite glass with chromium- and zirconium-oxide additives have shown high resistance to gamma-neutron bombardment. The foam glasses, having a density of the order of 0.25-0.6 gm/cm, have withstood temperatures above 600°C. Specimens were subjected to hot neutron streams (10^{18} neutrons/cm^2) in a reactor for 84 hours without experiencing loss of mechanical strength, the report claimed.

Second Liner Press Installed At Goodyear

Goodyear Aviation Products Div. is installing a second 10-million-lb. Verson curing press for the production of *Polaris* and *Minuteman* motor case liners. A prime item in a planned $500,000 liner facility expansion effort, the huge press will hold full pressure up to 25 hours while controlling temperatures to within several degrees. Dimensional tolerances of 0.005 in. are within the capabilities of the new press. Both the new and the "old" presses are identical, giving Goodyear the largest production ability in existence in solid-rocket motor liners.

PROPULSION

Allison to build Titan III TVC Tanks

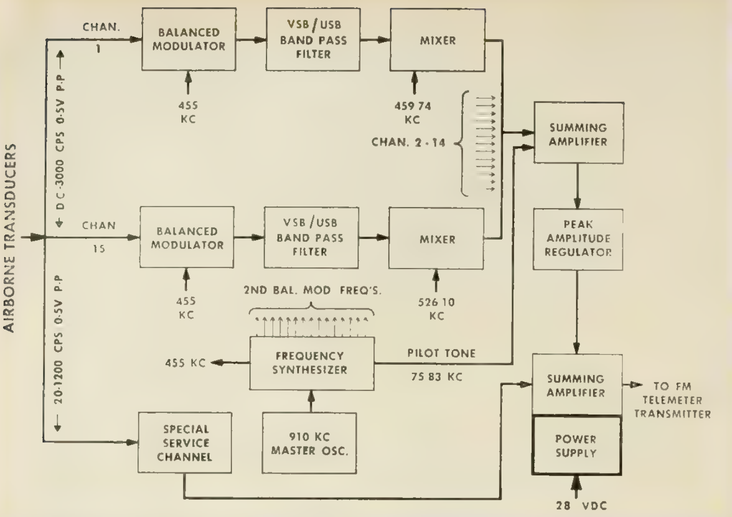
Pressurization and injectant tanks for the thrust-vector-control system associated with the 120-in. solid boosters for the *Titan III* launch vehicle will be built by Allison Div., General Motors. The tanks, one to a booster element, will force fluids under high pressure into the solid exhaust nozzles causing side pressures and hence a measure of thrust control. Variations of both amount and direction injected into the exhaust streams will result in vehicle direction control. United Technology Center, contractor for the solid boosters, is finishing off a set of test towers for the TVC tanks and injection systems at their Morgan Hill test facility. The Allison tanks will arrive next September.

Giannini Develops Nucleonic Fuel Gage

A nucleonic fuel gaging system aimed at zero-g applications in the *Apollo* program is under development at Giannini Controls Corp. for North American Aviation's Space and Information Systems Division. The system will measure the fuel supply for 16 reaction control engines. The $1.5 million system uses radioactive isotopes to detect diminishing fuel without placing sensors or other instruments in physical contact with the chemical. The total system will consist of the radio-isotope source, detector, computer and display panel.

Hybrid Tunnel in Operation at UTC

Combustion phenomena within hybrid rockets is being examined in a "wind tunnel" designed by Raymond J. Muzzy and Charles Wooldridge of United Technology Center. The behavior of air into which a mixture of hydrogen and nitrogen is forced will be studied. Air acts as the oxidizer. The combustion boundary layer in the tests chamber will be checked to determine temperature, gas velocity and gas concentrations.



ORTRONIX INC.'S Vestigial Sideband Telemeter.

space electronics

Vestigial Sideband Offers Increased T/M Capability

Technique gives 13:1 increase over FM/FM systems; compatible with conventional equipment

by Charles D. LaFond

A NEW TELEMETRY technique, called Vestigial Sideband (VSB) frequency modulation, has been developed offering a total bandwidth-utilization capability increase of 13:1 over standard FM/FM telemetering systems.

Designed by Ortronix, Inc., Orlando, Fla., the prototype flight and ground equipments now being tested are compatible with any conventional FM telemetery transmitters, receivers or tape recorders, developers claim. A company funded project, it has grown out of earlier single-sideband flight subsystems produced for NASA's *Saturn* program.

Capable of handling any type of data, the system provides a 63% efficiency in transmission-bandwidth utilization. Frequency capability extends to the dc range.

● **Broad application**—Company officials disclosed that in addition to application for missiles and spacecraft, VSB can also be used on the ground where there is a need for many channels of wideband data.

A marked advantage of the VSB system over existing techniques is its good channel-to-channel impulse line correlation and its ability to handle pulse data transmissions such as PCM or standard PAM commutation format.

The airborne telemetry system has 16 input channels, capable of handling data with input frequencies ranging from dc to 3,000 cps, plus one special channel to handle frequencies from 50 to 3,000 cps.

The 16 data inputs are combined into a single subcarrier complex signal, by frequency multiplexing, which modulates an FM telemetry transmitter. Through the use of frequency translation, the fifteen 3-kc channels are frequency multiplexed into a spectrum up to 75.833 kc to assure compatibility with existing FM transmission and reception equipment.

A pilot tone technique is used for accurately regenerating airborne frequencies and for amplitude reference. The 4.74-kc pilot tone is derived from a 910-kc highly stable crystal oscillator in the flight unit.

Since absolute phase coherence is required between the 4.74-kc airborne and ground signals, it was mandatory that the transmitted pilot tone frequency be the lowest utilized frequency in the system, developers said. Therefore, the pilot tone was placed in the Channel 1 carrier position, and Channel 1 was placed in the Channel 16 position.

In addition, these changes in placement increased the transmission bandwidth utilization so that the system offers a total data bandwidth of 47.9 kc and a transmission bandwidth of 75.835 kc of sub-carrier spectrum.

● **Extending the system**—Ortronix uses a modulation technique that employs all of one sideband and a vestige or part of the other sideband to extend the system into the dc range. Changes in design of the airborne telemeter, as compared to other single sideband systems, incorporate the use of a balanced modulator, which can be properly nulled with respect to carrier signals at a predetermined dc level. In the VSB system, the level represents 2½ volts dc of incoming data voltage.

The ground station—a 15-channel bandswitching demodulator—is compatible with both single sideband and vestigial sideband. For reduction in cost and size, Ortronix designed the equipment so that any channel can be viewed through the use of a single switch. For data reduction and engineering development, it was not felt necessary to look at more than one channel at a time. Double conversion technique is used both in the airborne telemeter and the ground station.

In operation, designers claim, any type of data can be fed to the airborne vestigial single-sideband multiplexer. The output (50 cps to 75kc) is directed to a standard FM telemetry transmitter. Received on the ground by standard FM receivers, the output can be put on tape or fed directly to the demodulator.

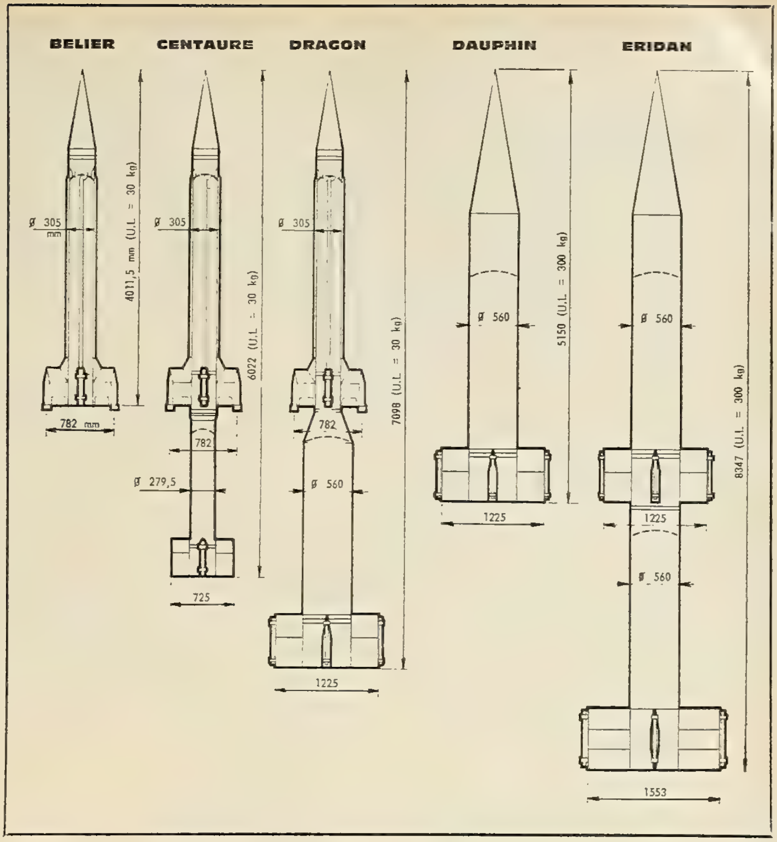
The transmission of almost 48 kc of data in the 75 kc of baseband spectrum on one FM RF link makes the system about 13 times more efficient than standard FM systems. Conventional systems, Ortronix points out, usually handle 4 kc of data in the 75 kc baseband spectrum on one link.

The system will also handle voice, since all significant frequencies in voice are below 3,000 cps. During recent tests at Ortronix, telephone quality signals were achieved.

The voice transmission capability gives the system added potential as back-up for voice communications in spacecraft.

Sud-Aviation At Work on Family of Five Rockets

Low-cost series of solid boosted sounding rockets includes Belier, Centaure, three still in development



THE FRENCH FIRM Sud-Aviaion has unveiled a family of upper-tmosphere exploration rockets coverng ranges from 50 to 370 miles and roviding payloads of 66 to 660 lbs.

Developed under the sponsorship of he French government's CNET agency, nd displayed at the recent Paris Air how, the family includes two members —*Centaure* and *Belier*—which are lready in production and operation. The others—the *Dauphin, Dragon,* and *ridan*—will be available shortly.

The latter three rockets benefit from ecent progress in the design of boosters, both in the technology of cases and ozzles and in the development of composite solid-propellant grains.

All of the rockets are powered by olid boosters, and each stage is stabiized by fixed fins. The same basic nethod is used to separate stages and cientific payloads of all five—a ringhaped hollow charge with multiple firng points cuts the case skin.

Sud-Aviation is developing ground upport equipment for the family—paricularly assembly rigs, balancing rigs nd mobile launchers.

The company says the rockets are elatively inexpensive both in purchase nd operation for three reasons: 1) the olid booster; 2) the small number of stages (one or two); and 3) the absence of any guidance or control system.

● **The family**—The *Belier,* Sud's first production rocket, is a single-stage vehicle consisting of a booster motor, loaded with Jericho "epictete" solid-propellant grain (208 kg) with 4 fins, and a nose cone housing the payload. The nose cone is either the standard nose or a cone specially designed to the requirements of a scientific operator. The standard cone has a sealed compartment, 35-liter capacity, and an internal rack suitable for a command set, a telemetery unit and a radar responder. The cone has a sealed connector block for 125 test or liaison circuits and for 8 coaxial plugs.

Belier's booster motor is fitted with four longitudinal channels for running single or coaxial electrical cables. The fins are designed to house the telemetry, command and radar responder antennas.

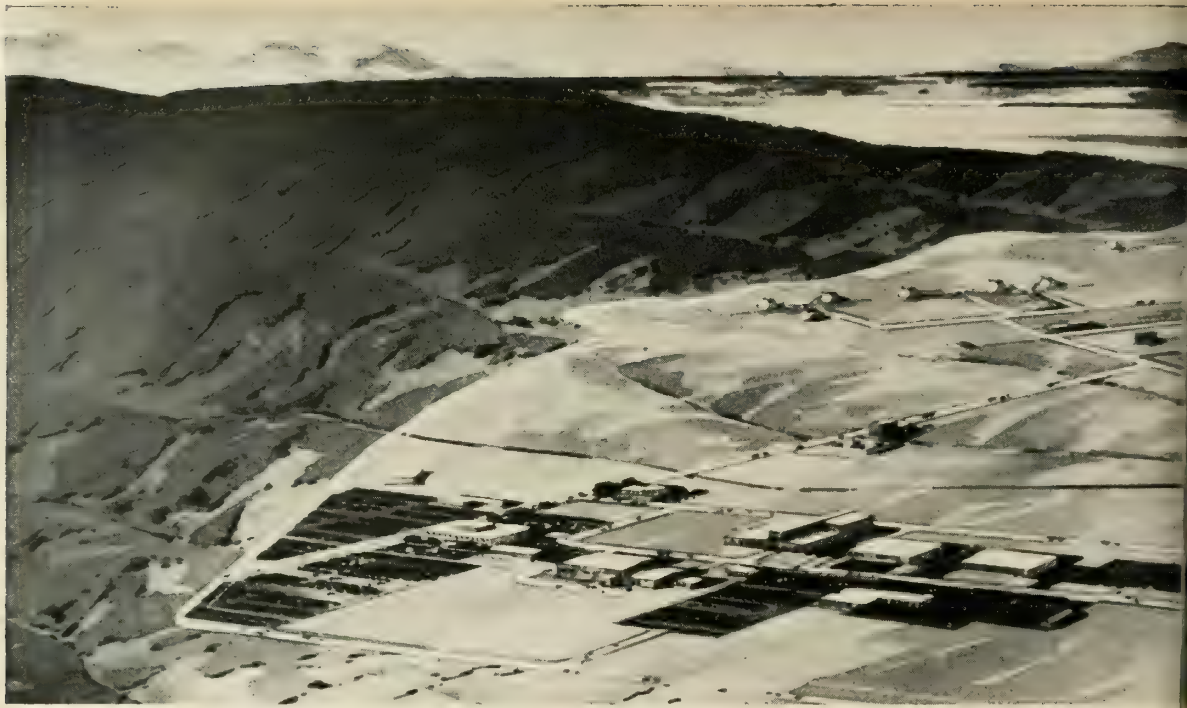
Sud's second production sounding rocket is the two-stage *Centaure.* The first stage comprises the launching booster, loaded with Venus "Plastolite" solid-propellant grain (94 kg). The *Belier* is the second stage.

The three other Sud rockets under development are designed around the same high-performance booster of high mass ratio, loaded with Stromboli "Plastolane" solid-propellant grain (685 kg). This booster is designated S2 (Stromboli 2 meters long).

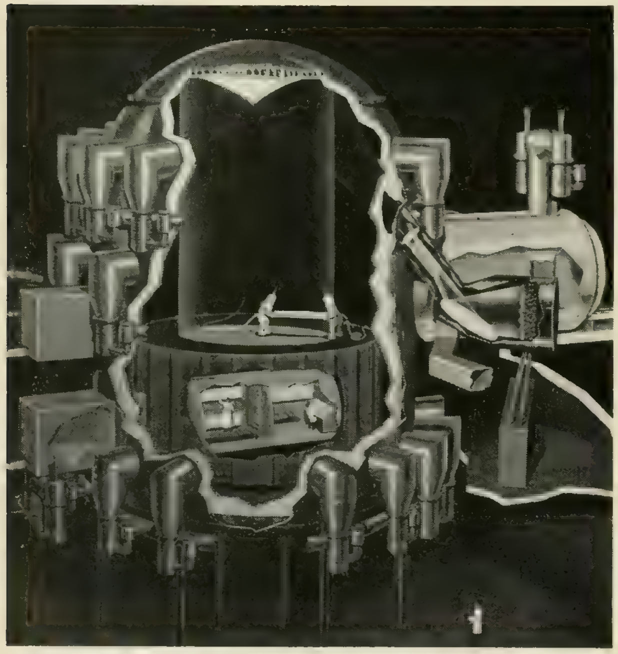
First of the three new rockets now under development is the *Dauphin,* a single-stage vehicle comprising a finned S2 booster, a cylindrical-conical nose, approximately 560-mm diameter, into which scientific equipment is installed according to requirements. This allows housing of 100-to-300-kg payloads with capacity of 150 to 300 liters.

The second new rocket under development is the two-stage *Dragon,* with a finned S2 booster as first stage and the *Belier* as second stage. The third new rocket is the two-stage *Eridan,* which has a finned S2 booster as first stage and the *Dauphin* as second stage. The diameter of the basic S2 booster is close enough to that of the *Véronique* so that the nose cone containing the payloads may be common to the *Dauphin, Eridan* or *Véronique.*

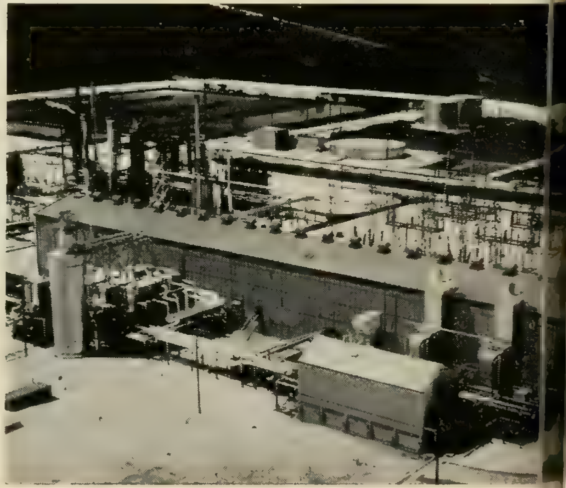
Payloads of the Sud rockets may be returned to the ground at speeds compatible with the total recovery of equipment or animals. Recovery is achieved through the following sequence: nose cone separation; drogue chute ejection; low altitude ejection of main chute; and payload release on ground. ■



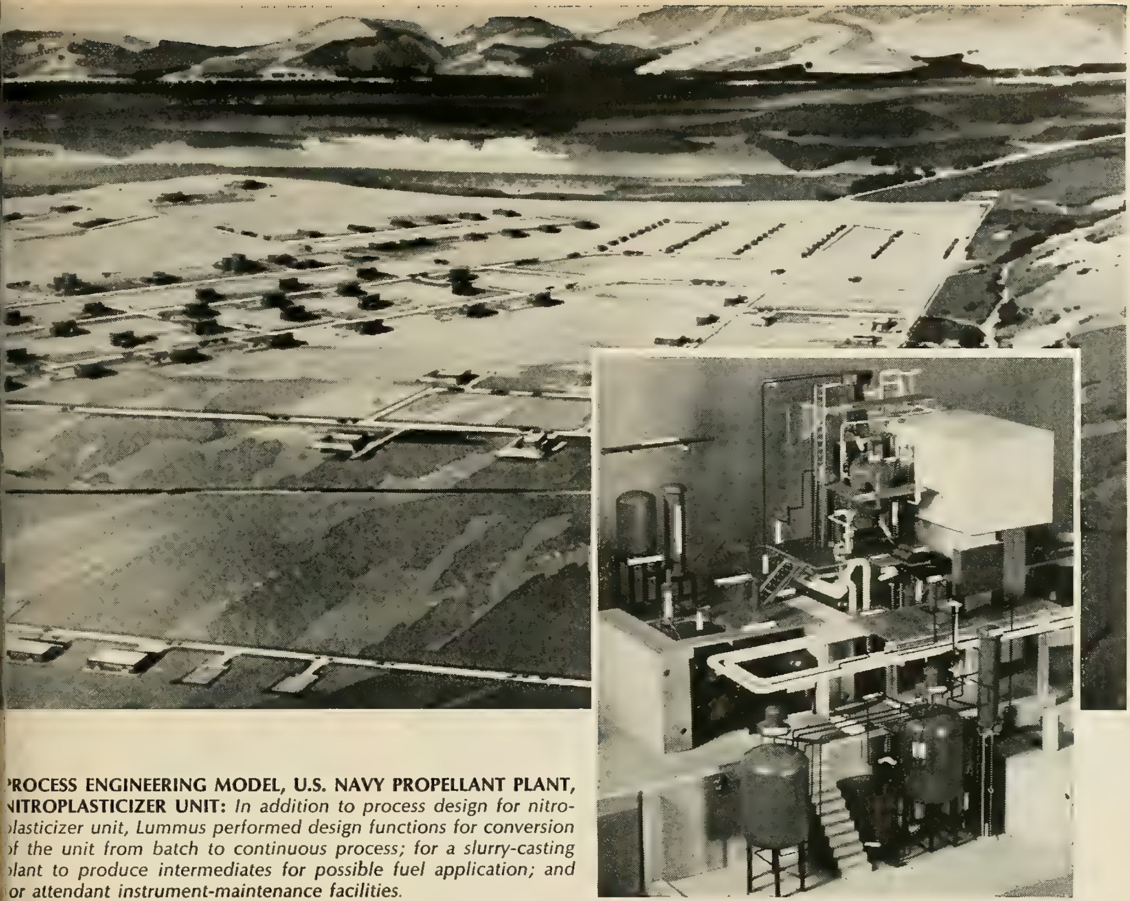
SOLID PROPELLANT PRODUCTION FACILITY—U.S. AIR FORCE PLANT #78: *Lummus' architect/engineering design for this propellant complex included auxiliary facilities for MINUTEMAN horizontal engine testing, propellant handling and storage considerations, and rocket-engine handling.*



LUNAR ENVIRONMENTAL RESEARCH FACILITY—U.S. ARMY CORPS OF ENGINEERS: *Lummus performed the conceptual engineering for this simulator which established the engineering feasibility to provide for vacuums up to 1×10^{-8} torr, temperatures as low as −423°F, and solar radiation twice the intensity of the noonday sun—up to 130 watts/sq. ft.*



WORLD'S LARGEST LIQUID HYDROGEN PRODUCTION FACILITY—U.S. AIR FORCE PLANT #74: *Lummus designed, engineered, and constructed the hydrogen-production process phases of this plant to produce 99+% pure hydrogen, which is then liquefied through cryogenic processes.*



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Tantalum-Tungsten Alloy Used in Agena Vehicle

NRC-produced refractory to see service in secondary propulsion units; firm offers first ultra-high vacuum gauge calibration service, applies pressure-attenuation

by John F. Judge

CATHETOMETERS are used to read mercury columns indicating pressures in the ultra-high-vacuum gauge-calibration equipment in operation at NRC. Gauges can be absolutely checked to pressures as low as 10^{-9} torr. The Norton Co. subsidiary will offer the service to industry and government on a dollar-fee basis.

A HIGH TEMPERATURE refractory—tantalum-10% tungsten—produced by National Research Corp., Metals Div., Newton, Mass., will go into secondary propulsion thrust chambers on the *Agena,* target vehicle for *Gemini.*

Textron's Bell Aerosystems Co. has conducted an extensive development effort on thrust chambers for the program. Bell is building the *Agena* engine and the secondary propulsion system under subcontract to Lockheed for the NASA project.

The characteristics of the refractory alloy are drastically affected by the interstitial impurities contained. NRC, which controls the entire operation from powder production to ingot, uses double vacuum arc melting of high purity powders or electron beam melting followed by arc melting in the production process to achieve "clean" metal.

The Bell rocket system thrust ranges from 0.5 to 500 lbs. Their radiation-cooled chambers have operated successfully in single firings extending as long as one hour while producing a specific impulse equal to 320 sec. They have been operated with stable skin temperatures exceeding 2700°F.

The chambers have been subjected to hundreds of test firings during which cyclic operation with very short pulses of rocket thrust were demonstrated. Also, tests with reproducible, continuous firings for periods as long as 3600 seconds were carried out.

Bi-propellants used in the chamber were nitrogen tetroxide and a 50/50 blend of hydrazine and unsymmetrical dimenthlhydrazine. When Bell ordered the tantalum-tungsten from NRC, the instructions were to provide the alloy with a very fine grain structure so tha it could be subjected to extremely rigorous tests.

Tantalum-10% tungsten looks, or the surface, like an odd choice for space it weighs 0.6 lb./cu. in., costs from $40 $60 a pound, and oxidizes rapidly a high temperatures.

On the plus side of the ledger, how ever, the alloy has high temperature cap ability (melting point of 5600°F), i one of the easiest refractories to fabri cate, and is extremely resistant to cor rosion/erosion.

One advantage of tantalum-10% tungsten is its ability to go from cryo genic to very hot temperature (4500°F and still retain its ductility. Molybde num and tungsten lost ductility whe subjected to such thermal shock effect say NRC experts.

The alloy is tough—approaching th strength of pure tungsten at high tem peratures—and retains much of th ductility and workability of pure ta talum at room temperatures. It can easily formed with conventional meta working equipment, and impact resistance is better than almost any other material—including austenitic stainless steel.

The major production use of tantalum-10% tungsten for aerospace applications is for auxiliary rocket nozzles. The high temperature capability of tantalum-10% tungsten has been extended even further with new coatings.

NRC developed a new rocket nozzle alloy composite under Navy sponsorship which had a surface melting point within a few hundred degrees of any known material and higher than any known element.

The alloy is basically a layer of tantalum carbide on 90% tantalum-10% tungsten. In addition to extreme high-temperature capability, the combination is stronger and more heat-erosion resistant. In test firings, rocket nozzles made from this alloy worked well while plain tantalum-tungsten nozzles eroded and failed.

Other uses for tantalum-tungsten alloys under development include gas control systems, exhaust piping, main rocket motor parts, and leading edge material. Nuclear space reactors posing the dual problems of heat and corrosion represent a potential application for the alloy. Several companies are already experimenting with tantalum-tungsten tubing for such purposes.

- **Vacuum calibration**—In another area, NRC is esablishing industry's first ultra-high vacuum gauge calibration service on an absolute basis down to 10^{-9} torr. The service will initially be confined to 10^{-8} torr ranges.

Accurate determinations of pressures in these ultra-high vacuum regions have usually been individual research efforts unless they could be conveniently extrapolated from higher pressure readings.

The NRC approach is through use of a dynamic pressure-reduction or attenuation scheme involving steady-state flow through a cascade of differentially pumped stages connected by carefully defined orifices.

The overall pressure attenuation is determined largely by these orifices. Gas transfer to and from chamber walls is a source of error only during non-equilibrium flow, say NRC experts, and its effect is minimized by using relatively large flow rates.

Effects of variations in diffusion pump speed are also minimized by using oversized pumps restricted at the throat by well-defined orifices, so that effective pump speed is largely determined by the orifice conductance.

The overall pressure ratio is exceptionally stable, say NRC designers, and can be accurately calculated simply from the mechanical configuration and its dimensions. It is practicable to obtain pressure ratios from 1 to 10^6.

In applying the pressure-attenuation method to gauge calibration, the basic principle starts with the creation of a region of very low pressure. The gauge under test is connected to this region. The pressure in this area is accurately related to a higher pressure region by a system of pressure attenuating orifices.

This higher pressure is chosen to fall within the area conveniently measured by another instrument—such as the well-known McLeod Gauge—with complete accuracy.

- **Design explained**—The system is divided into five chambers with four pressure reduction stages. Each chamber is pumped with its own unit. The McLeod Gauge is attached to the second chamber. The gauge to be calibrated is connected to the fifth chamber.

Three orifice plates permit a pressure-reduction range from half to a millionth of the reference pressure with accuracy. Each plate is 6.22 mm thick, and has three circular holes measuring 3.96, 8.74 and 31.74 mm. dia. Each orifice plate is backed with a bulkhead plate containing a two-inch hole drilled off-center. The orifice plates can be rotated to bring any orifice into line with the large bulkhead hole.

The bulkhead and orifice plates are ground flat and lapped to make the leakage between them negligible compared to the conductance of the orifice. The restricting orifices above the diffusion pumps have been similarly designed. Experimental checks have been made to confirm that the pressure ratio between individual stages agrees with theoretical predictions.

- **Broad service potential**—Early experimental work with the system proved the concept and indicated a capability of providing accurate gauge calibration over the range of 10^{-4} to 10^{-9} torr, say NRC engineers.

The scheme may be extended to still lower pressures, limited only by the state-of-the-art in ultra-high vacuum technology. Initial experiments confirmed that the steady state response of a properly designed hot cathode ionization gauge below 10^{-4} torr is essentially constant down to the range at which the X-ray effect predominates.

The equipment can be employed to determine response to other atmospheric gases—singly and mixed. In addition, the study of outgassing procedures and the effect of aging on variations in the sensitivity of ion gauges is possible.

The new service will be offered through NRC's Space Vacuum Lab. Company spokesmen say the charges will be about $250 for calibrating new gauges, with a two-day delivery time expected. ■

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New Houston Control Facility May Direct Gemini Sooner Than Planned

Integrated Mission Control Center to combine Goddard and Mercury Control functions; capabilities to be greater; launch decision to remain at Cape

by Michael Getler

Houston—NASA's budding Integrated Mission Control Center (IMCC) complex here may be exercising either primary or back-up control of manned orbital *Gemini* flights earlier than anticipated.

Construction at the center is proceeding on schedule, NASA officials here report. This, combined with the set-back in *Gemini* manned launch schedules, could plug IMCC into *Gemini* operations considerably before the first rendezvous missions. There is even a possibility that the center will play a role in the first manned orbital shot, now slated for late next year.

First attempts at rendezvousing the *Gemini* capsule and *Agena-D* target vehicle are slated to begin early in 1965. IMCC is expected to begin checkout of its equipment and programs and start initial flight simulations with both *Gemini* and *Apollo* programs next summer. Full operational status is expected in the fall of 1964.

Original intent was to use the Mission Control Center (MCC) at Cape Canaveral as the primary control center for the *Gemini* suborbital and manned orbital flights, switching to IMCC at Houston for the rendezvous flights. MCC, the former *Mercury* control, will still control the suborbital flights, but top NASA officials here point out that if IMCC is ready several months before the first manned orbital shot, sufficient flight simulations could be run and experience developed to allow IMCC to handle this shot with MCC serving as a back-up.

IMCC Flight Operations Div. Chief Christopher C. Kraft, Jr. told Missiles and Rockets that "it would be my guess that we will use both on the early orbital flights, probably maintaining control at the Cape, but having the flexibility to use either or both."

Kraft also points out that MCC will be used in support of *Gemini* regardless of IMCC status, serving as launch control headquarters. The actual *Gemini* launch decision will be made at the Cape, with responsibility shifting to IMCC at lift-off.

• **Combined chores**—Essentially, IMCC, when operational, will combine the roles previously played by *Mercury* control and the Goddard Space Flight Center (GSFC) computing facility. However, IMCC's capabilities and flexibilities, due to the nature of the missions they will support, will be far greater.

The concept of the center is one in which highly flexible and highly automated data retrieval, processing, and display methods will allow a relatively small number of flight controllers at Houston to exercise control over the entire global ground support effort—from preflight checks to recovery—connected with manned spaceflight.

Heart of IMCC, which will be worth about $60 million fully equipped, is the three-story mission operations wing—which houses the real-time computer complex and communications links on the first level, and the mission control rooms and staff technical support on the upper floors.

With the exception of the computer complex, responsibility for implementation of the IMCC requirements generated by NASA rests with Philco Corp., a Ford Motor Co. subsidiary. Philco's basic contract is for $33.8 million and extends through July, 1964, with a year of maintenance operations following. The basic contract does not include about $6 million in government-furnished equipment (GFE), which NASA will supply and Philco will integrate into IMCC.

• **Computerized versatility**—The computer complex and certain launch data links between the Atlantic Missile Range and Houston are IBM's responsibility. The firm signed a letter contrac with the space agency in December and a final definitized award for $36. million is now at NASA headquarter for signing. The IBM effort extend through FY 1965.

The computer complex here will b tied not only with generation of trajectory information, as was the case i *Mercury*, but with extensive system analysis associated with the infinite possibilities of rendezvous maneuvers, an with flight simulation.

IBM will supply four 7094 computers to IMCC, in addition to a num ber of smaller 1401 computers and associated equipment. The 7094's will be divided between the two Mission Control Rooms planned for IMCC, allowing one MCR to support an actual mission while an advanced flight simulation can be carried on simultaneously in the other MCR.

For example, Paul H. Vavra, manager of IMCC's Ground Systems Project Office (GSPO), notes that a single 7094 could receive and process network data and drive the TV and larger rearward projection displays at IMCC in support of an actual mission, with a second computer operating in parallel as a back-up.

Either of the other two could also be hooked into the loop as further back-up if no simulation were being run. In a simulation, one computer would be used to generate the simulated data and the other to run the program.

- **Simulation**—The IMCC simulation program will use the background gained on *Mercury* training as a major input but will also significantly expand on the degree of simulation achieved. At IMCC, two simulated remote tracking sites will be tied in with the spacecraft simulator, thus allowing for a complete closed-loop simulation of orbital passes over remote sites. The simulated sites will also be tied into IMCC. Also, trajectory displays and data will be supplied from computer programs rather than tapes, as was the case in *Mercury*.

In effect, IMCC will have the capability of complete closed-loop simulation both in *Gemini* rendezvous and *Apollo* orbital and lunar missions. Kraft emphasizes that the flight "ground rules, particularly for rendezvous, evolve from these simulations."

The first *Gemini* mission trainer is expected to be available late this year at Houston and will be used primarily for astronaut training until the IMCC complex is completed, when its use will expand. The second delivery, by *Gemini* prime contractor McDonnell Aircraft Corp., is expected in 1964 at the Atlantic Missile Range. It will also be tied in with IMCC.

Kraft reports that an extensive simulation effort by IBM is now going on at IMCC, with MSC and GSFC inputs. It covers development of rendezvous trajectory, spacecraft system inputs, and real-time programs for *Gemini*. IBM has been operating some of its 7094 computers here since January in an interim building. A Univac 490 communications processor has also just been leased and installed as GFE. If this device proves acceptable, NASA says, it will buy two of the $1.3-million units for IMCC.

- **Goddard responsibility**—The Goddard computing facility will continue to support *Gemini* until IMCC becomes operational, but will not serve as a back-up after that time. Though Goddard's role will decrease in this area, it will remain large in terms of manned spaceflight support for *Gemini* and *Apollo*. Major inputs to GSFC concerning data requirements, rates, displays, and man-machine interfaces will flow from IMCC.

In addition to continued operation and maintenance of NASA's remote tracking sites, GSFC will implement station modifications to allow use of new PCM telemetry receiving equipment and digital command systems in support of both programs.

Further along, it will supervise the transition to S-band operation of all near-Earth stations in support of advanced *Apollo* flights. The move to a unified frequency will make the network compatible with the Deep-Space Instrumentation Facility (DSIF), which probably will also be added to in support of *Apollo* to insure against conflict with concurrent planetary probe-tracking requirements of Jet Propulsion Laboratory.

Two additional DSIF-type stations are under consideration for this application, one in the central U.S. and another in southern Europe.

Also in support of *Apollo*, officials here discuss the possibility of adding two new shipboard tracking links to the *Apollo* network—one downrange from Bermuda to improve data on *Saturn* SIVB stage burnout, which occurs about 1200 miles from AMR during *Saturn IB* firings and about 1500 miles downrange during *Saturn V* launchings, and another off Johannesburg to increase tracking capability of the South African site during the lunar trajectory injection maneuver.

- **Recovery plans**—Commenting upon IMCC concepts for land recovery of both advanced *Gemini* and *Apollo* capsules, Kraft told M/R the current feeling is that the existing and planned tracking network should be augmented with transportable ground-controlled approach trailers capable of S-band operation with communications, tracking, and guidance inputs.

"We feel that is the way we ought to go," says Kraft, "but we will probably have a design study first." Kraft says these studies may be let "in a couple of months," followed by a prototype implementation contract.

Though the early *Gemini* water landings do not present too severe a problem, land recovery of *Gemini*—and especially *Apollo*—will be formid-

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able. The *Gemini* footprint is roughly described by a 300-500 mile ellipse, but the range of re-entry control possibilities for *Apollo* can extend from between 1,500 to 5,000 miles from re-entry to landing.

In another major IMCC subsystem, Kraft reports that planners here have now completely established display requirements which will give the center flexibility and "not tie it down to development of a particular program." He says display hardware should be available for "shake-down" within six months.

Although the formal contract has not yet been signed, funds have already been allocated for General Dynamics/Electronics in San Diego to supply a large portion of the electronics necessary for display—the basic digital-to-TV conversion equipment to handle real-time computer and other digital outputs. The contract, estimated to be worth about $4 million, will be the first major one in this area.

• **Pending contracts**—NASA officials here report that though system and subsystem design efforts are now under full steam, not very many of the final procurement specifications are written.

Procurement of TV camera and monitoring scopes, worth "less than a million dollars" is "coming close to award," according to NASA, and final specs are being reviewed on the video switching matrix contract, which will probably run about $1 million. Additional procurements from Philco for TV, telemetry, and communications links between IMCC and AMR—separate from the IBM responsibility for the tracking data portion—also remain.

Furthermore, some major procurements of consoles, keyboards, and large screen projection displays, both video and scribbing plotter types, will be awarded "within the next few months."

There is no requirement for any tracking capability at IMCC, though officials here point out that a near-Earth-type station may eventually be set up in the general area. The Clear Lake area just outside Houston, where IMCC is going up, had been shown to have a fairly high electronic noise level which would rule out deep space antennas.

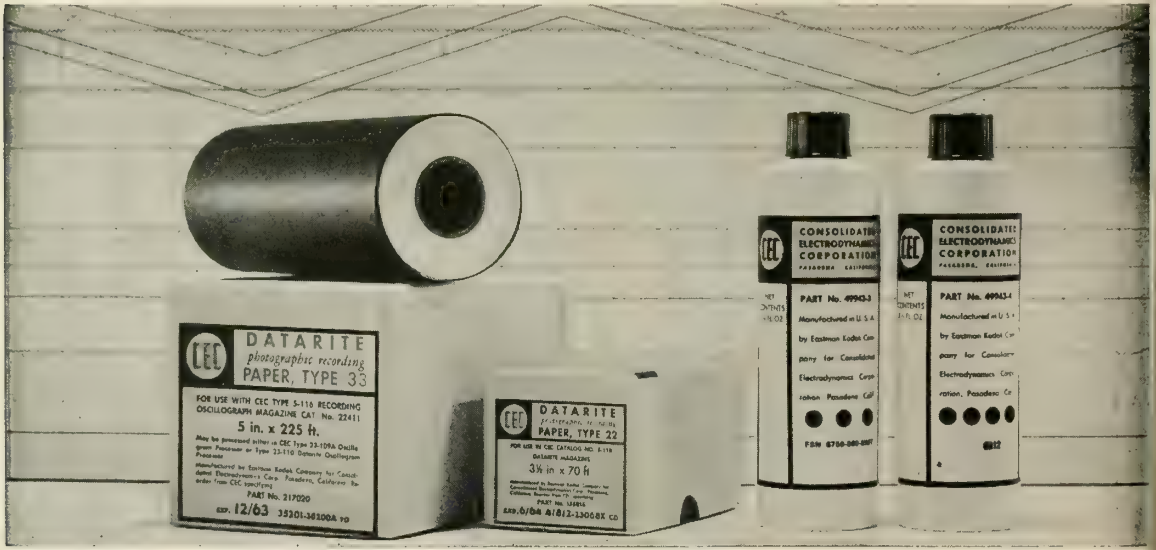
However, an electronic systems test facility now under development at Clear Lake eventually will be linked to IMCC, an interim facility is expected to be occupied this fall, and funds for a permanent housing are included in the FY 1965 budget request.

According to planners here, this will essentially be a bench operation at first devoted to early *Apollo* electronics and their compatibility with ground receiving-station gear. Eventually, other IMCC inputs from this facility are expected to include lab studies of telemetry data flow and use of remote-site digital processing.

• **Chain of command**—Though the operational structure of IMCC is still not completely firm, the paths by which IMCC is being implemented can be drawn. Basically, the operational requirements and design of IMCC originate within the offices of Kraft's Flight Operations Div. From there, they move to the GSPO, where the FOD requirements are presented to Philco and IBM for hardware design compatible with IMCC.

GSPO reports to G. B. Graves, assistant director for information and control systems, who in turn reports to Walter C. Williams, deputy director for mission requirements and flight operations.

Williams currently wears another hat, that of the assistant director of operations to whom Kraft reports. It is unofficially predicted here that Kraft probably will move up into the assistant director slot shortly. ■



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Saenger Urges Germans To Build Space Ships

Rocket pioneer feels that Europeans could profitably build aeronautical space transports, orbital stations

PROFESSOR Eugen Saenger, world-famed scientist known as the "father of the Dyna-Soar," recently wrote a paper in Germany on "Some Lucrative Examples of Space Travel." Of major interest to M/R readers is the following portion of the article, here published for the first time in English.

COMMUNICATION satellites are by no means the only example of lucrative space travel hardware. Even today some other hardware in the major space-travel R&D countries is in such early state of technological development that competition from European and especially the German industry appears rather promising if we in Europe will not tarry too long.

We are favored in these fields because both the United States and the Soviet Union are currently tied down in their efforts caused by the competition for the first lunar manned landing and possibly landings on neighboring planets.

The most topical of such space travel hardware, which is receiving greater attention both in the major space-travel countries and in parts of Western Europe, is the reliable and economical space airplane, the *aeronautical space transports.*

Their task will be the safe and economic transport of passengers and cargo 1) with high speed between points on Earth and 2) from the Earth surface to Earth orbit and from Earth to Moon by fully using all possible and available ground installations (airports) in Europe, by reducing current transportation costs by multiples through the great number of flights or a regular transport system, by constant re-use of the spacecraft (similar to our commercial transports) and by introducing the most economical powerplants, especially the chemical oxygen/hydrogen rocket engine and the nuclear uranium/hydrogen convection rocket engine.

This aeronautical space transport promises to become a financially most profitable project for space travel because of the varieties of its economic applications in Earth express traffic and in near-Earth space travel up to the Moon.

The current importance of this space travel craft—not at all new in its conception—stems from the transition of space travel from its original pioneer stage to the stage of increased demands in reliability and economy.

• **From X-15 to X-20**—Technically speaking, it deals with closing the gap which exists today between the American *X-15* experimental aircraft that can attain speeds up to 2,000 m./sec. by its own power and the projected *Dyna-Soar* aircraft that glides back to Earth from orbit without the help of propulsion.

We deal, for example, with sort of an aircraft in one- or two-stage versions that will fly by its own power from the Earth surface into Earth orbit, conduct there certain tasks and maneuvers, and then aided by its wings will glide back to the Earth and land there like a glider.

This results in certain navigational problems arising from the fact that the piloting of such airplanes must be done partly manually and partly by automatic steering.

These specific characteristics, especially the desired frequent re-use capability similar to common commercial aircraft, allow us to expect an increased improvement in reliability compared to current ballistic space transports, because regular flight-testing is now possible before final use. Beyond this we can expect increased economy because production costs for the single craft are distributed (due to re-using the craft) on many flights, contrary to the ballistic transports which today get lost after they've been used once.

The application of such spacecraft in the Earth air traffic seems to become one of the most interesting side products of space travel, an Earth air transport system with the physically highest speed between points on the Earth surface whereby distances around half the Earth could be covered in one and a half hours, and also the highly economical transportation costs for cargo which can be compared to regular air transport costs.

• **Station potential**—Perhaps attention can be focused on another, a third example of a prospective lucrative space travel project which at this moment lies even further in the future.

Upon creation of an economic transport system from Earth surface to Earth orbit, establishment of a large or maybe of numerous *manned orbital stations* may be started.

These, too, permit, according to many experts, complete economic self-sufficiency after a comparable initial period—much as do large airports—because of the manifold possibilities for use.

For example—as interim landing sites for space travel, fuel depots, supply depots, construction yards for deep spacecraft, test sites for technological space travel development, astronaut training centers, tourist centers, hotels, sanitariums, weather stations, communication stations, geodetic surveillance stations, navigation stations for sea, air and space travel, astronomical observatories, high-altitude radiation laboratories, general physics and biology laboratories without gravitational interference—and hundreds more.

It appears very probable that private enterprise together with the interested governmental agencies will actively participate in such projects as soon as the technological and especially the economic prerequisites are met. ■

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New Firms and Divisions

American Optical Co., Southbridge, Mass., has created a Space-Defense Div. to strengthen its position in the space and National defense field. The new division will begin operation August 1 and will consolidate the firm's Fiber Optics operation, commercial laser activities and the present activities of the J. W. Fecker Div., which has been producing electro-optical missile tracking systems and calibration and test equipment for missile guidance devices. . . . *Infrared Industries, Inc., Santa Barbara, Calif., has established the Radiation Electronics Div. to carry out the company's advanced projects in the field of electro-optics. The new division will also encompass the work currently being done by the company's Instrumentation Div. The new division is said to be already underway on several classified contracts.* . . . Garrett Corp., Los Angeles, has changed the name of its Airsupply-Aero Engineering Co. division to Airsupply Co. Airsupply offers sales representation for firms in defense, missile/space and other specialized commercial fields. . . . *Martin Co.'s Nuclear Div. (Baltimore) has established a new Radiation Effects team to direct efforts of nuclear physicists and engineers toward solving problems associated with the effects of nuclear radiation on new materials and systems. Radiation effects work previously done by Martin engineering sections will be reoriented and increased in scope by the team. Emphasis is to be placed on weapons effects and radiation hardness of weapons systems.*

Industry Facilities

Aerospace Corp., Beverly Hills, Calif., has broken ground for two new buildings, one to house company headquarters and the other, a library. Two R&D facilities are already underway on the same 40-acre site. Headquarters building will be six stories tall and will contain 123,000 sq. ft. of executive and administrative office space. . . . *The Radio Corp. of America has announced plans for a $11.6-million expansion program at its Lancaster, Pa., tube plant to provide an additional 200,000 sq. ft. for color TV picture tube engineering and conversion tube manufacturing.*

International

Creed & Co., Ltd., manufacturer of teleprinter and data processing equipment and British affiliate of International Telephone and Telegraph Corp., plans to move its operations at Croydon, England, to a site near Brighton, England, over the next two years. The move will be in an effort to consolidate under one roof the activities currently being conducted at several locations in the Croydon area.

Company Representatives

Vacuum-Electronics Corp., Plainview, N.Y., manufacturer of leak detection and high and ultra-high vacuum equipment, has opened a newly enlarged West Coast regional and district sales office, located at 14827 Ventura Blvd., Sherman Oaks, Calif. . . . *Space Hardware, Inc., Dallas, Tex., has been named exclusive sales representative in Texas for Allan Aircraft Supply Co., North Hollywood, Calif.*

Potpourri

The second Space Industry Assistance Symposium, to be held July 30 on the Rice University campus, Houston, will be co-sponsored by NASA's Manned Spacecraft Center and the Houston Chamber of Commerce. Theme of the meeting will be "How We Buy, What We Buy . . . Oriented Toward Business in the Houston Area." MSC will display products and equipment, conduct classes with question-and-answer sessions, and discuss requirements for doing business with NASA. Other participating agencies include: U.S. Small Business Administration, General Services Administration, Raytheon Co., General Eletcric Co., North American Aviation, Aerojet-General Corp. and Grumann Aircraft Engineering Co. . . . *According to the Deutsch & Shea, Inc., Engineer/Scientist Demand Index just released, technical manpower recruitment activity during May was the lowest since 1961. The downtrend in recruiting activity began in February and is expected to continue through the summer. Data for the D&S index comes from 43 participating publications, including newspapers in 21 major market areas and technical journals representing a variety of industrial and technical fields.* . . .Motorola's Semiconductor Products Div. will offer a two-part course on integrated circuits design July 14-Aug. 2 in Pheonix, Ariz. The course will be aimed at electronic circuit and systems design engineers and is intended to acquaint the industry with the theoretical and practical design considerations of the technology. . . . *General Telephone has been authorized by the Federal Communications Commission to buy stock in the Government-sponsored Communications Satellite Corp. as a common carrier. Number of shares has not been disclosed.* . . . The Summer, 1963, edition of the Directory of San Diego County Electronic Manufacturers lists 80 companies, largest number in the area's history. Total employment figure is up 212 people from March '63 to June, an increase of 2.2%. One firm was dropped from the list; nine were added. Thirty-seven of the companies have been born in the last three years.

AWARDS

AIR FORCE

$7,729,029—**Carrier Air Conditioning Co.**, Syracuse, N.Y., for building and installation of environmental control systems for the Wing 5 *Minuteman* missile base under construction at Francis E. Warren Air Force Base, Ohio.

$2,300,000—**International Business Machine Corp.**, New York City, for maintenance of a computer system.

$1,900,000—**Beckman Instruments, Inc.**, Fullerton, Calif., for provision of a time division multiplexer subsystem for use at the Atlantic Missile Range.

$1,300,000—**Avco Corp.**, Stratford, Conn., for production of re-entry vehicles.

$1,300,000—**American Machine & Foundry Co., Advanced Products Group, Hydrospace Div.**, Buffalo, N.Y., for 4,000 units of a splice case and 2,000 pressure component assemblies for linking underground communication assemblies at various *Minuteman* sites.

$1,200,000—**General Motors Corp.**, Detroit, for work on a classified program.

$99,000—**Raytheon Co.**, Lexington, Mass., for a three-phase study of strain-transducers.

ARMY

$14,800,000—**International Telephone & Telegraph Co., ITT Federal Laboratories Div.**, Nutley, N.J., for production, installation, engineering, management, operation and maintenance of the European Area Communications System.

$6,700,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for work on a communications system (2 contracts).

$2,698,925—**Belock Instrument Co.**, College Point, N.Y., for training devices for the *Hawk* missile.

$2,500,000—**Martin Marietta Corp.**, Orlando, Fla., for *Pershing* missile engineering services.

$2,400,000—**Raytheon Co.**, Lexington, Mass., for parts and component gear for the *Hawk* missile.

$2,300,000—**Western Electric Co.**, New York City, for work on the *Nike-Hercules* missile system.

$2,300,000—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, Utah, for additional research and engineering services on the *Sergeant* missile system.

$1,800,000—**Collins Radio Co.**, Dallas, for tactical communication radio communication terminal sets.

$1,600,000—**Ets-Hokin and Galvin**, Houston, for construction work on a NASA space environment simulation facility.

$1,600,000—**Beech Aircraft Corp.**, Wichita, Kan., for 115 missile targets.

$1,100,000—**Stanford Research Institute**, Menlo Park, Calif., for research work.

$1,000,000—**General Electric Co.**, Utica, N.Y., for electronic equipment.

$1,000,000—**Raytheon Co.**, Waltham, Mass., for *Hawk* missile battery sets.

$1,000,000—**Philco Corp.**, Philadelphia, for work on a classified electronic program.

$124,000—**Yardley Electric Corp.**, New York City, for research and development leading to development of a hermetically sealed, rechargeable zinc-silver battery for space application.

$89,000—**Electronic Associates, Inc.**, Long Branch, N.J., for production of a prototype hybrid analog-digital computer system with ancillary parts.

$46,300—**Consolidated Western Steel**, Los Angeles, for parts production of components for the *Little John* missile motor.

$39,800—**AFC Electronics**, Riverdale, Md., for *Nike-X* training studies and research.

NAVY

$9,800,000—**Gilfillan Corp.**, Los Angeles, for radar sets for tracking and data acquisition gear for surface ships.

$4,100,000—**General Dynamics Corp., Electronics Div.**, Rochester, N.Y., for transmitters-receivers.

$2,700,000—**Hughes Aircraft Corp.**, Fullerton, Calif., for scanning radar sets.

$2,100,000—**Hazeltine Corp.**, Little Neck, N.Y., for production of radar indicators.

$1,500,000—**Raytheon Co.**, Lexington, Mass., for engineering services to develop performance requirements and drawings for radar modification kits.

$1,400,000—**General Electric Co.**, Philadelphia, for nuclear reactor plant components.

$1,400,000—**Raytheon Co.**, Wayland, N.Y., for radar unit modification.

$1,300,000—**Bethlehem Steel Co.**, Quincy, Mass., for submarine shock test vehicle.

$1,100,000—**International Business Machines Corp.**, Washington, D.C., for computers for classified work.

$987,000—**Radio Corp. of America, Defense Electronics Products Div.**, Moorestown, N.J., for redesign of AN-FPS-16 radar pedestal.

$497,000—**Atlantic Research Corp.**, Alexandria, Va., for continued research and development on solid propellants.

$61,600—**Lockheed Aircraft Co., Lockheed Missiles & Space Co.**, Burbank, Calif., for research in the field of anti-submarine warfare photographic techniques.

NASA

$5,000,000—**Radio Corp. of America's Service Co.**, Cherry Hill, N.J., for operating and maintaining satellite data acquisition facilities near Rosman, N.C., and Fairbanks, Alaska.

$2,000,000—**Simmonds Precision Products, Inc.**, Tarrytown, N.Y., for design and fabrication of an electronic measurement system.

$827,000—**Martin Co., Electronics Systems and Products Div.**, Baltimore, for infrared horizon sensors to be used as part of the *Saturn* space booster guidance system.

$389,580—**Thiokol Chemical Corp., Wasatch Div.**, Pocatello, Idaho, for machinization, fabrication and assembly of skirt and bracket assemblies for two supersonic wind tunnel compressors.

$100,000—**Republic Aviation Corp.**, Farmingdale, N.Y., for work to determine the biomedical and human performance requirements for a manned Earth-orbitting space station.

$96,417—**Avco Corp.'s Avco-Everett Research Laboratory**, Everett, Mass., for a study of superconducting magnet systems.

$95,866—**Avco Corp.'s Avco-Everett Research Laboratory**, Everett, Mass., for research on advanced superconducting magnets.

$74,707—**Callery Chemical Co.**, Callery, Pa., for a year-long study of ways to liberate water, hydrogen and oxygen from the moon's rocks.

Emerson Electric's Electronics and Space Div., St Louis, Mo., for reliability engineering studies (undisclosed amount).

INDUSTRY

$2,100,000—**Raytheon Co.**, Lexington, Mass., from **Sylvania Electric Products, Inc.**, for traveling wave tubes which boost conventional radar energy for the *Nike-X* anti-missile missile program.

$2,024,233—**Bendix Corp., Eclipse-Pioneer Div.**, Teterboro, N.J., from **North American Aviation's Autonetics Div.**, for accelerometers to be used in the guidance and control system of the *Minuteman* missile.

$1,500,000—**Giannini Controls Corp.**, Duarte, Calif., from **North American Aviation's Space and Informations Systems Div.**, for a propellant gaging system capable of practical operation in a zero-gravity environment for Project *Apollo*.

$1,500,000—**PneumoDynamics Corp.**, Cleveland, from the **Boeing Co.**, for design and manufacture of parts for the *Minuteman* weapon system.

$1,375,000—**American Machine & Foundry Co.'s Advanced Products Group**, Greenwich, Conn., from the **Marion Power and Shovel Co.**, for the design and development of the servo hydraulic system for the *Saturn V-Apollo* crawler-transporter.

$1,200,00—**Raytheon Co.**, Lexington, Mass., from **Bendix Corp.**, for production of subassemblies for the *Talos* missile.

$1,000,000—**Northrop Corp.**, Beverly Hills, Calif., from **United Technology Center**, for engineering services in support of the *Titan III* solid propellant booster program.

$850,000—**Lockheed-California Co.**, Burbank, from **United Technology Center**, for production of eight-foot diameter injection manifolds for a new Air Force rocket booster program.

$740,000—**Quantic Industries, Pelmec Div.**, from **Avco Corp.'s Lycoming Div.**, for continuing production of the *Minuteman* re-entry vehicle separation system.

$300,000—**Ling-Temco-Vought's Temco Electronics Div.**, Dallas, from the **Martin-Denver Div.**, **Martin Co.**, for production of 23 C-band pulse tracking transponders to be used in the *Titan III* test program.

$250,000—**Motorola Inc.'s Military Electronic Div.**, Scottsdale, Ariz., from **General Electric' Missile and Space Div.**, for a two-month stud of a random-orbit, medium-altitude communications satellite.

$150,000—**Lear Siegler, Inc., Astro Structures Div.** El Segundo, Calif., from **Federal-Mogul-Bearings, Inc.'s Arrowhead Products Div.**, for th manufacture of large meter tubular fuel line for the *Saturn* booster.

$130,000—**Texas Instruments, Inc., Transisto Products Div.**, Dallas, from the **Boeing Co** for the manufacture of electronic transistor for the *Minuteman* weapon system.

$60,000—**Chemical and Aerospace Products, Inc** Gardena, Calif., from **Lockheed Missiles an Space Co.**, for 15-layer interconnect matrice for the *Polaris* missile.

$50,000—**Chemical and Aerospace Products, Inc** Gardena, Calif., from **Martin-Denver Div.** **the Martin Co.**, for electronic circuitry in th pilot-run of the *Titan III*.

Lockheed Propulsion Co., Redlands, Calif., fro **North American Aviation Co.**, for develo ment and production of solid propellant rock motors for the *Apollo* launch escape syste (undisclosed amount).

Applied Electronics Corp., Metuchen, N.J., from **North American Aviation's Space and Information Systems Div.,** for development and building of the pulse code modulation telemetry unit for the ground checkout system of the *Apollo* spacecraft (undisclosed amount).

Sperry Rand Corp., Vickers, Inc., Div., Detroit, from **North American Aviation, Inc.,** for production of pneumatic pitch-and-roll control actuation systems for the paraglider recovery system of the *Gemini* space capsule (undisclosed amount).

General Motors, Inc., Allison Div., Indianapolis, Ind., from **United Technology Center,** for provision of pressurization and injectant tanks for the thrust vector control system of the *Titan III-C* (undisclosed amount).

Leach Corp., Controls Div., Cedar Rapids, Iowa, from **Collins Radio Co.,** for development and fabrication of test maintenance units for the *Apollo* program (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Digital data switch, gate rack and associated equipment. In accordance with specifications—Item IFB L-3685. Bid opening 7-16-63. Requests for IFB and RFP will be furnished to the extent available on a first-received, first-served basis.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Monochromotor, grazing incidence scanning. McPherson Model 255 or equal—1 each. IFB A-7407. Bid opening 7-16-63.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

S/L/E and materials (except that to be furnished by the Government) for constructing a nitrogen-cooled baffle and associated nitrogen piping system, installation of equipment and miscellaneous structural work for an existing space power chamber at the Lewis Research Center. Work includes but is not limited to providing a suitable cover over a 22½-ft. opening; expanding, forming, cleaning and testing of Government furnished tube-in-tube copper sheet; fabrication and installation of the baffle assembly consisting of the aforementioned copper sheet supply and return headers; all miscellaneous supports, rollers, plates, etc.; fabrication and installation of the liquid nitrogen and instrument air piping systems; insulation construction of a work platform and access ladder to the vapor separator tank; construction of a work platform inside the space power chamber; miscellaneous bolting materials, gaskets, shims, etc.; painting, cleaning and testing. Specifications and drawings will be furnished to the extent available on a first-received, first-served basis. IFB CPO-6458. Bid opening 7-17-63.

Procurement and Production Office
496L (ESSXK)
Laurance G. Hanscome Field
Bedford, Mass.

Contract for research and development to provide a precision orbit determination prediction and targeting program. To be negotiated with Space Technology Laboratories, Inc., Space Technology Center, One Space Park, Redondo Beach, Calif. PR ES-3-496L-3627. Note: For information only. No RFP available.

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- data handling equipment, for radars and telemetry, spanning from Cape Canaveral to the Indian Ocean providing a high-capacity data transmission system with over 3000 bits/sec. and error rate less than 10^{-6} over a 3 kc rf channel
- display systems driven by multiple digital sources for range and missile operations control

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On May 20, American Aviation Publications, Inc., the publishers of the Aviation DAILY and MISSILES AND ROCKETS, published the first issue of the MISSILE/SPACE DAILY. It is a factual news service designed to bring you accurate and comprehensive industrial and governmental reports every twenty-four hours.

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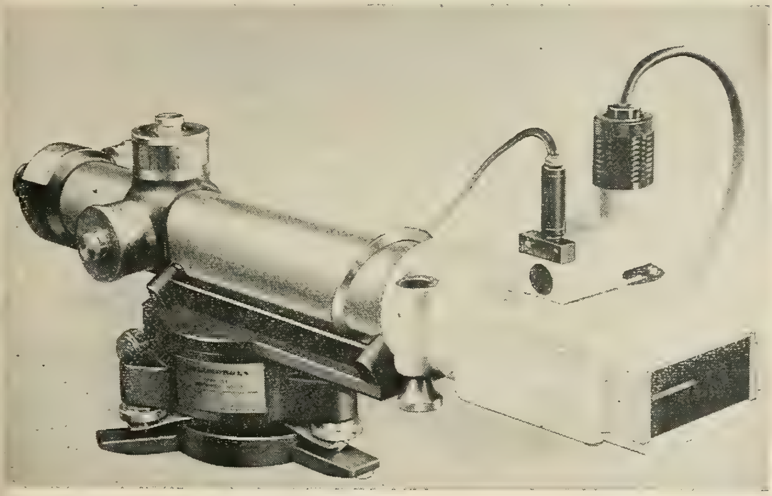


New Product of the Week: Pointing Interferometer

Kollmorgen Corp. is marketing a compact pointing interferometer with sensitivity of 0.02 arc sec., for measuring angles up to 2,000 seconds of arc.

In addition to sensing and measuring the rotation of a plane mirror, about an axis perpendicular to the line of sight, this high precision interferometer can measure the thickness of thin films, surface parallelism, refractive index differences, and homogeniety to transparent materials (schlieren). It also handles many of the tasks usually assigned to autocollimators but with about five times the precision.

The Model K421 pointing interferometer mounts onto the Kollmorgen Model K120 or K122 alignment telescope and certain other instruments having an NAS 2.25-in-dia. barrel.

Circle No. 225 on Subscriber Service Card

Power-Aging System

A power-aging system for integrated microminiature circuits has been developed by Wyle Laboratories' Manufacturing Div. for the Astroelectrics Laboratories of Westinghouse. The system consists of two independent modules. One operates at ambient temperatures for stressing up to 2160 FEB's, while the other power-ages up to 720 FEB's at 125°C. An electronic system was included with the chambers which adapts them for dynamic testing of flip-flop circuits, high-gain triple NAND circuits, and clocked dual NAND circuits.

Circle No. 226 on Subscriber Service Card

DC-Supplies

DC standard supplies with voltages from 0 to over 1,100 volts are available from Cohu Electronics, Inc., Kin Tel Division.

The Model 321 uses six 11-position detent dials and a range switch to set the level of output voltage. Accuracy of the output voltage is within 0.01% of setting. Stability for eight hours is 0.0025%; for 30 days, 0.005%. Current up to 25 milliamperes is available at all voltage levels. The range switch permits selection of output voltage in three ranges. The six decades provide resolution of 10 microvolts on the 10-volt range, 100 microvolts on the 100-volt range and 1 millivolt on the 1000-volt range.

Circle No. 227 on Subscriber Service Card

Sphericity Interferometer

Engis Equipment Co. has developed a Sphericity Interferometer capable of examining spheres up to 1 in. in dia. to accuracies of one micro inch.

Through a special optical system, more than one-third of the entire sphere appears as if it was truly flat. Therefore, in the proper adjustment, parallel fringes appear in the eyepiece when viewing a perfect ball and a true "contour" map of all defects can be developed, requiring three positions for complete analysis.

The unit introduces interferometry, the basic technique of measuring length into the aerospace, ballbearing and precision industries generally.

Circle No. 228 on Subscriber Service Card

Frequency Detector Module

A transistorized Frequency Detector has been developed by the Electric Division, Daystrom, Inc., provides a compact, reliable module for FM detection for telemetry, dc readout of input frequency, and automatic frequency or speed control. The transistorized cylindrical module, measuring only 1¼" x 4" with standard octal socket, produces a d-c output voltage proportional to frequency of the input square wave signal.

Circle No. 229 on Subscriber Service Card

30-Joule Laser

Maser Optics, Inc., is marketing a lightweight ruby laser with a power output of 30 joules. The output can be as high as 40 joules under certain conditions. The Model 3020 weighs less than 15 lbs. and measures only 12.5 x 4.5 x 7.5 in. and has a fully-automatic cryogenic cooling system. The ruby rod supplied with the Model 3020 is a 0.04 to 0.05% chromium-doped rod, encapsulated in a silvered elliptical cavity. This rod is optionally flat or TIR type.

Circle No. 230 on Subscriber Service Card

Microwave Power Generator

Three microwave power generators are available from Raytheon Commercial Apparatus and Systems. The PGM-10 series delivers precisely controlled microwave energy for laboratory research projects such as the production of free radicals, excitation of electrodeless discharge lamps for spectroscopy, raman spectroscopy, and interferometry.

The generators deliver 10 to 100 watts of power at 2450 megacycles, and will accept voltages between 105 and 130 at 60 cycles. Power consumption is 385 watts.

Circle No. 231 on Subscriber Service Card

Tunable Crystal Mounts

Available from FXR, the broadband crystal mounts, models Y205D and K205D, DF, offer improved impedance matching and sensitivity control over the frequency ranges of 12.4-18.0 Gc and 18.0-26.5 Gc, respectively.

Features incorporated in these models include a broadband stepped ridge waveguide transformer section that matches the waveguide impedance to the impedance of the crystal detector. Another modification involves a noncontacting sliding short. The sliding short consists of a three-section choke, which is micrometer-driven to insure precise positioning of a maximum RF field at the crystal detector.

Circle No. 232 on Subscriber Service Card

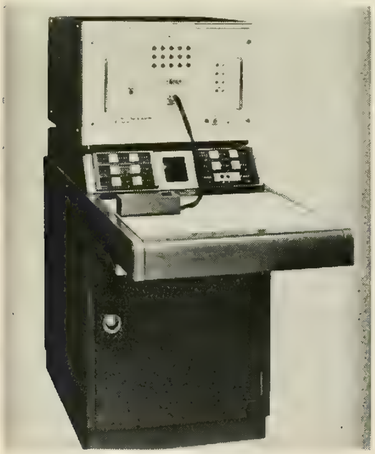
Crystal Discriminator

Systems Inc. has available a linear crystal discriminator for FM demodulation in portable transistorized communication systems. Linear band-width and operating temperature range of —40° to 65°C make it suitable for FM equipment with 50 kc channel spacing. Model A-28, Type D-D-11.5-50 has a peak-to-peak bandwidth of 50 kc over a center frequency of 11.5 mc. Harmonic distortion is less than 3% for FM input signals with a 10 kc deviation at a modulation rate of 1,000 cps. Audio output is 0.30v for an RF input of one volt at ±10 kc deviation. Source impedance is 390 ohms with load impedance of 100,000 ohms. The unit is designed to withstand shock of 100 g's per method 202A and vibration method 201A of Military Standard 202B.

Circle No. 233 on Subscriber Service Card

Semiconductor Sorter

A 16-bin Rotimatic sorter, Model 660, for use with the firm's basic Model 654 transistor and diode tester is being marketed by the Industrial Products Group of Texas Instruments Inc. The bins are mounted on a rotary turntable for easy access. Clear plastic fronts allow visual checks during sorting. Each bin holds up to 800 TO-5 or 1,500 TO-18 transistors. Sorter operation is controlled through sorting logic built into the 654 equipment. Signals are generated at the end of each test sequence to actuate sorting relays which position a sorting chute over the proper bin.



Sorting time is 100 milliseconds bin to bin with maximum sort time of 800 milliseconds.

Circle No. 234 on Subscriber Service Card

Compact Power Supplies

A series of power supplies capable of high dc voltages and power levels has been developed by High Voltage Engineering Corp.

The Series 7 includes 18 standard models, with outputs ranging from 100 kilovolts at one ampere to one million volts at 10 milliamperes.

The 300 KV ICT at 60 ma is 7 ft. x 4 ft.

Circle No. 235 on Subscriber Service Card

Compound Amplifier

Designed for circuits requiring very high gain, high-input impedance and low noise, Raytheon's Darlington compound amplifier features a dc current gain of 1,600 to 10,000.

The RM3-22 is constructed of two-high-gain silicon planar transistors interconnected within a standard TO-18 case. Breakdown voltage is 1,000v, and leakage current is 5 nanoamps.

Circle No. 236 on Subscriber Service Card

Miniature Multi-Tester

A VOM miniature multi-tester with a sensitivity of 20,000 ohms per volt dc and 15,000 ohms per volt ac and with 18 different measurement ranges has been developed by International Instruments, Inc.

The VOM-22 assures foolproof range selection and positive electrical connection by means of a rotary printed circuit switch, and has five different ranges for a-c voltage (0-15-50-150-500-1500), five for d-c voltage (0-5-15-150-500-1500), four for d-c milliamperes (0.5-5-50-500) and four for resistance (0-2k-20k-200k-2m ohms). Accuracy of the instrument is claimed to be within ±3% for d-c ranges, ±5% for a-c ranges and ±3% of linear scale for resistance ranges.

Circle No. 237 on Subscriber Service Card

Level Detecting Amplifiers

A line of Level Detecting Amplifiers, capable of signal detection at discrete levels from 50 microamp to 50 milliamp, and from 0.6 v to 400 volts, with minimum room temperature tolerances of ±1%, has been developed by Sectron, Inc.

These expoxy-encapsulated solid-state modules, designed to meet MIL-E-5272 and MIL-E-5400, provide power amplification as high as 10^6, and are capable of switching 100 watts ON in 0.1 microsecond, and OFF in 20 microseconds.

Circle No. 238 on Subscriber Service Card

Pulse Transformer

Developed by the Weldmatic Division/Unitek Co., the Model 1028D is a bench mounted stored-energy welding control unit that permits maximum utilization of stored energy from the 500-watt second Weldmatic power supply Model 1024B. Control unit utilizes built-in watt-second meter, which indicates stored energy in capacitor bank or power supply. Other features include: stepless heat selector and weld/no weld switch. Specifications: weight, 46 lbs. net; ventilation, forced air cooling; and maximum power rating. 500 watt-seconds.

Circle No. 239 on Subscriber Service Card

Junction Laser

A junction laser which operates continuously at a power output of more than one watt has been developed by General Electric Research Lab.

The power output of the gallium-arsenide laser demonstrates a tenfold improvement over what has previously been achieved with ordinary ruby and gas lasers, and also demonstrates remarkable efficiencies in the range of 20-30%, requiring only 5-6 watts of power to produce the one-plus watts of output.

A heat-transfer design makes it possible for a current equivalent to 4,000 amperes per square centimeter to be passed through the gallium-arsenide junction. The junction in the Garfinkel-Engeler laser is about 1/1000th of a square centimeter in cross section. The coherent light emitted is in the near-infrared range (8400Å).

Circle No. 240 on Subscriber Service Card

Spectrum Analyzer Modules

Three interchangeable modules covering frequency from 20 cps to 25 mc in the same main frame for their solid-state portable Model TA-2 universal panoramic spectrum analyzer have been developed by Singer Metrics Div., the Singer Co.

The portable TA-2 and its modules are completely transistorized. It operates from rechargeable nickel cadmium batteries for a minimum of four hours. Recharge—trickle or rapid—is automatic when the unit is plugged in overnight or during an operation from ac lines. Any line 95-130, 190-260 volts, 50-1000 cps may be used. The ultrasonic device covers 100-600,000 cps.

Circle No. 241 on Subscriber Service Card

Production Line Equipment

A contamination-proof, multi-station production line unit has been developed by Matthews Research, Inc. The "White Bench" exceeds AF Tech Order 00-25-203 and makes it possible to achieve better than Class 4 cleanliness standards at any point within the regular production process. The device is equipped with a pressurized floating polyvinyl enclosure that provides positive and total environmental separation between the work in process and the operator.

Large final filters remove 99.975% of all particles 0.03 microns or larger with each pass of the uniformly distributed downsweep laminar air flow. Large double-door entry/exit air locks insure absolute environmental isolation control during the introduction of materials into the work area.

Circle No. 242 on Subscriber Service Card

Multi-Frequency Generator

A 500-watt generator for sonic and ultrasonic processing over a wide frequency range has been developed by Macrosonic Corp.

The generator is a broad band instrument, (5 kcps to 2 mcps). Among the applications for the device are: hydrophone and microphone testing, medical ultrasonics, biological studies, metals processing.

Specifications for the multisons generator call for continuous duty at full output, 125 ohms impedance, and power requirements of 111-120v, 60 cps, 20 amps at 500 watt output.

Circle No. 243 on Subscriber Service Card

Attenuator

A turret-type decade attenuator, designed for RF signals in the dc to 1000-mc range is being marketed by Telonic Industries, Inc.

The TAD-50A contains three separate turret attenuators covering respectively 10 db in 10 steps, 50 db in 5 steps and 50 db in one step. Combined, they can provide any attenuation value from 1 to 110 db in 1-db increments. Each of the turret units consists of a precision machined rotor that carries pi section resistive elements designed for optimum match and attenuation accuracy. As the shaft is rotated, separate pads make a connection through silver-plated contacts with the input and output BNC connectors.

Maximum error at 900 mc is 0.5 db for the 1db-step turret, 0.5db ±5% for the 10 db-step turret, and 3 db for the 50-step unit. Insertion loss at this frequency is less than 0.5 db and is down below 0.2 db at 30 mc.

Circle No. 244 on Subscriber Service Card

BOEING OPENINGS ON SATURN S-1C

Boeing has primary developmental, building and test responsibility for NASA's Saturn S-1C advanced first stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

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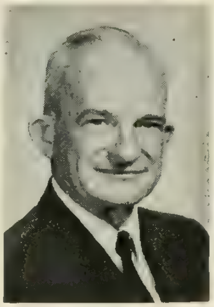
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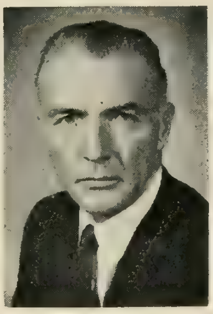
SLATER

LEIFER

Dr. Martin H. Bloom: Appointed technical assistant to the president of General Applied Science Laboratories, Inc., Westbury, N.Y.

George C. MacDermut: Appointed senior district representative for the central marketing area of the Northrop Corp., Dayton, Ohio.

Dr. Walter A. Fraser: Appointed president of the Hayward Scientific Glass Co., Whittier, Calif.

Joseph C. Miller: Joined the staff of National Transistor, a subsidiary of ITT, Lawrence, Mass., as contract administrator.

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Osmund T. Fundingsland: Appointed manager of the Santa Barbara, Calif., Laboratories of Edgerton, Germeshausen & Grier, Inc., Boston.

Soren C. Ibsen: Appointed radar marketing manager for United Aircraft Corp.'s Norden Div., Norwalk, Conn. **W. Robert Knapp** named guidance and control marketing manager.

E. A. Bellande: Elected chairman of the board and chief executive officer of The Garrett Corp., Los Angeles. **Harry H. Wetzel** elected president and **W. R. Ramsaur** elected executive vice president.

Dr. G. Russell Tatum: Elected vice president of Vitro Corp. of America, New York City. He will continue as head of the Silver Spring, Md., laboratory.

Sanford C. Sigoloff: Named vice president of Electro-Optical Systems, Inc., Pasadena, Calif.

Frederick M. Brose: Appointed production manager at Coleman Electronic Systems, Santa Ana, Calif.

John S. Wheaton: Elected vice president-administration for the Bissett-Berman Corp., Los Angeles.

Arthur B. Sperry: Named manager of manufacturing engineering for the eastern operation of Sylvania Electronic Systems, Needham, Mass.

Ryamond N. Okonski: Elected president and chief executive officer of Michigan-Dynamics, Inc., Detroit.

Lt. Col. Ralph P. Slater (USAF ret.): Former director of information for USAF's Office of Aerospace Research, joined the public relations firm of Washington Representation Inc., Washington, D.C.

J. Donald Blake: Appointed manager of reaction control systems in the research, development and engineering department of Thompson Ramo Wooldridge's Tapco Div., Cleveland.

Charles F. McMorrow: Appointed manager of engineering and research for the Riverdale, Md., plant of ACF Electronics Div. of ACF Industries, Inc.

L. Wayne Mullane: Appointed vice president and general manager of Aerojet-General Corp., El Monte, Calif.

Richard P. Axten: Appointed director of public and financial relations of the Raytheon Co., Lexington, Mass.

Meyer Leifer: Named director of the Systems Engineering and Management Operation (SEMO) of Sylvania Electric Products, Inc., Waltham, Mass.

Robert L. Strawbridge: Elected senior vice president for Houdaille Industries, Inc., Buffalo, N.Y.

Nelson G. Spoth: Elected a vice president of the Kolcast Industries Div. of Thompson Ramo Wooldridge, Inc., Cleveland.

Col. Glenn Crane: Appointed head of the *Nike-Zeuz* program project office on Kwajalein, replacing **Lt. Col. Edward M. Dooley** who was assigned to the Material Command Headquarters, Washington, D.C.

C. J. Meyer: Appointed Cape Canaveral marketing representative for the Douglas Missile and Space Systems Div.

Edmond E. Bisson: A National Aeronautics and Space Administration scientist in Cleveland, installed as president of the American Society of Lubrication Engineers.

Randall E. Porter: Named manager of applications analysis for the western region of Control Data Corp., Los Angeles.

Nat C. Myers, Jr.: Appointed director of marketing-communications products and services at the Industrial Products Div. of Fairchild Camera and Instrument Corp., Plainview, N.Y.

Richard G. Hartnett: Appointed assistant to the general manager of Acheson Colloids Co., Port Huron, Mich.

Richard P. Thornton: Named general manager of Elgin Laboratories, Inc., Waterford, Pa.

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JULY

IEEE 1963 International Symposium on Space Telecommunications, sponsored by Professional Technical Group on Antennas and Propogation, Boulder Laboratories, National Bureau of Standards, Boulder, Colo., July 9-11.

Meteorological Support for Aerospace Testing and Operation, sponsored by AIAA and American Meteorological Society, Ft. Collins, Colo., July 10-12.

National Association of Power Engineers, National Convention, Everglades Hotel, Miami, July 14-19.

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

The Sixth Annual Institute of Missile Technology, sponsored by the University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News*, University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference, sponsored by NBS Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug. 23.

AIAA Simulation for Aerospace Flight Conference, Deshler-Hilton Hotel, Columbus, Ohio, Aug. 26-28.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

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The Relationship

A FIRST PERUSAL of the extensive Stanford Research Institute study of the industry-government relationship, financed by Aerospace Industries Assn., results in an initial reaction that it is incredibly naive.

The Stanford researchers have reached conclusions about the procurement relationship which are long familiar to anyone intimate with the industry. The recommendations for action in this area likewise have that same old ring.

One is tempted to ask whether AIA might not have found a better use for $165,000.

Only after a study-in-depth of the more than 375 pages contained in both volumes of the SRI report does there come an appreciation of its true worth. The report will have a far-reaching effect on the industry-government relationship it discusses.

Its lasting value lies in the detailed financial and technical profiles of the industry.

The Stanford researchers have gone into the industry's financial affairs with a thoroughness previously unmatched. The pages of the report will enable firms in the industry not only to compare their financial status and performance with the industry as a whole but also to stack this industry against other manufacturing industries.

Many of the theories about profit margins and net worth in the industry no longer are theory. The Stanford report provides hard facts—facts that indeed disprove some of the pet theories of industry management but provide a firm basis for drawing up a realistic picture of the industry's financial status.

SRI reports that in the 15-year period under study, the industry had sales of approximately $2.40 per dollar of total assets whereas a cross-section of U.S. manufacturing corporations had sales of about $1.30 per dollar of assets.

This industry, relative to other manufacturing fields, has a markedly low assets-earnings margin. But the much higher ratio of sales to total assets brings the comparative return on total assets to a much more equitable status.

Not all new, this, but the Stanford report goes much further in depth to develop the financial figures behind it. It takes a look at median sales in relation to dollar of net property and finds that in the most recent period studied, 1957-61, the industry figure was $13.60 against $3.70 for other U.S. manufacturing.

This raises the question of whether this high level is attributable to a higher depreciation which would reduce the level in a comparison of gross property. Although conventional accounting practice does not include leased or government property in such a figure, Stanford probes into this as well and finds that while the adjusted turnover declines sharply, the figures for this industry still remain above that for the U.S. manufacturing cross-section, even after the adjustment.

Since any analysis of profitability depends greatly on the definition of terms, SRI looks at the profit picture for the 15 years from a number of viewpoints—rate of return on total assets, earnings margin, turnover of total assets and return on net worth. Both weighted averages and medians are considered. Although all figures are presented, SRI bases its own analysis on rate of return on total assets as a better basis for comparing the results of businesses with dissimilar financial structures.

THE PRESENTATION is thorough and detailed. It will enable industry and government to negotiate from a much firmer basis in the future. Lest anyone think it may not be representative, companies taking part in the survey included Bell, Martin, Boeing, General Dynamics, Grumman, McDonnell, North American, Northrop, Republic, Aerojet-General, Thiokol, Avco, Beech, Bendix, Curtiss-Wright, Douglas, Garrett, Lear, Lockheed, Ryan, United Aircraft, Rohr, Minneapolis-Honeywell, Sperry Rand, Thompson Ramo Wooldridge, RCA and Westinghouse Electric.

SRI's technical profile of the industry, based to a considerable extent on an analysis of manpower as well as products, contains some surprises because it extends its manpower survey to technical functions performed, not merely job titles.

But again, the surprises are not as important as the fact that theories have been replaced by hard figures.

On the basis of its financial and technical profiles, the Stanford study for AIA pictures an industry that still is not recognized by many who claim to be familiar with it. It notes that what is called the aerospace industry is made up of "two broad categories of activities that have increasingly diverged from each other in the past seven years." These are the missile/space segment and the aircraft segment, which SRI notes has essentially the same characteristics in 1961 that it had in 1955.

But in the missile/space field, SRI reports, there has been a marked shift in the function performed by prime contractors. This is, of course, to systems management, with its accompanying emphasis on research and development.

With this shift in mind, the Stanford researchers raise the question of whether this industry can continue to regard itself as a manufacturing industry for which developmental and systems-management activities provide support. They ask what financial, accounting and contracting practices might result if industry and government realistically regard their mutual business to be fundamentally development and systems management and gear themselves accordingly.

It is in raising this very basic question and in providing sound information on which to build an answer that the worth of the Stanford report lies—not in its answers to present procurement problems, which are symptoms and not causes. The AIA investment was well worthwhile.

William J. Coughlin

Systems Analysts & Preliminary Design Engineers for Advanced Space Guidance & Control Systems

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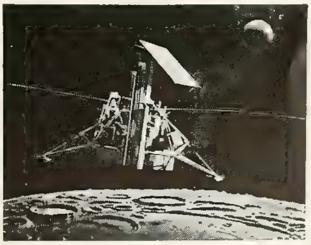

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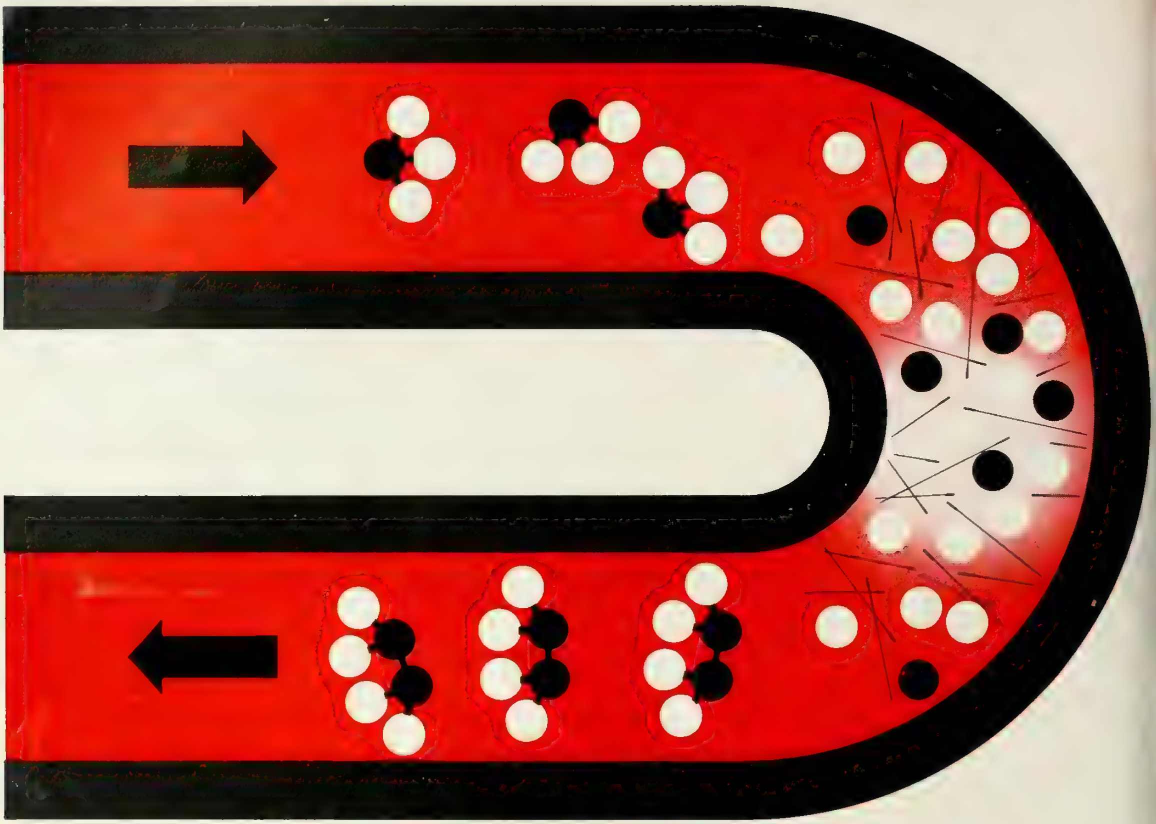

FISSIO-CHEMISTRY FOR CHEMICAL MANUFACTURING

A process that may represent a truly economical use of atomic power has recently been developed at Aerojet-General Nucleonics. ■ We call it fissio-chemistry. ■ We think it has great potential for the manufacture of high-energy compounds that now can be produced only by relatively inefficient and expensive means—and for the production of entirely new compounds, too. ■ Under Air Force sponsorship, AGN has already used fissio-chemistry to convert ammonia into hydrazine, the storable rocket fuel, at a rate projected to be just a fraction of the present cost. In the process, uranium fission fragments break up NH_3 molecules, which then reform into N_2H_4. ■ For the Atomic Energy Commission, AGN has also demonstrated the feasibility of fissio-chemical synthesis of NO_2 from air, suggesting the economical production of nitric acid and nitrogen fertilizers. This application may be of particular interest to emerging nations having limited domestic raw material sources. ■ AGN's continuing research in the field of fissio-chemistry is aimed at development of a production reactor in which the fissionable material is suspended directly in the reactants. This will make it possible to take full advantage of the high linear energy transfer and rapid quench inherent in a process that utilizes the recoil energy of fission fragments. ■ For additional information about fissio-chemical processing, write for AGN Active File No. 4.

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JULY 15, 1963

missiles and rockets

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Special Report: LEM Moves Out Of Design Phase

- MOSS Plans Face Slippage
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Centaur Test at Cape

AN

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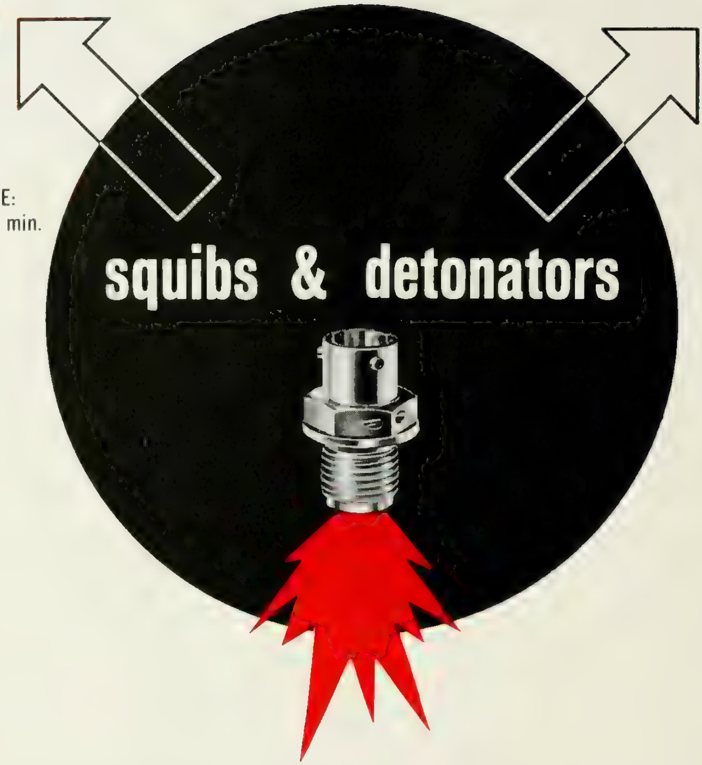

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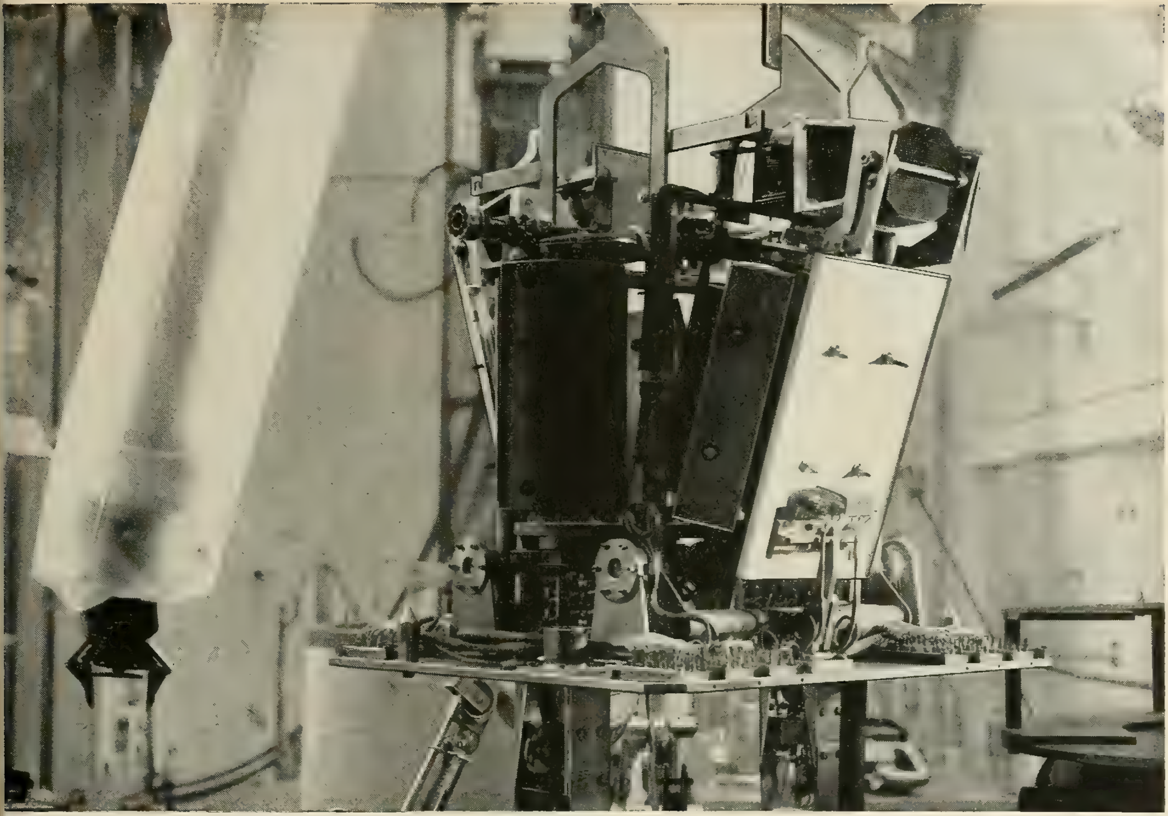

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 13, Number 3 July 15, 1963

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THE COVER

Centaur checkout vehicle atop Atlas first stage at Cape Canaveral, where it was used in tests of ground support equipment. Vehicle was recently sent to NASA's Lewis Research Center for space environment tests.

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letters

Sharp-eyed Readers

To the Editor:

I have just read your June 24 issue and found the informative news on p. 15. It shows how ignorant we are up here about the affairs in a country only a few miles away. I am, however, still not clear whether USSR has occupied the United States sometime prior to Oct. 3, 1962, or Maj. Gordon Cooper and Cmdr. Walter Schirra have defected to the USSR. At any rate, you have given the USSR a clean sweep of flight records for the past 12 months.

S. C. Liang
Rossland, B.C.
Canada

P.S. Pardon me for being difficult. I just cannot resist writing this note. I admit that I have never written about how good your work has been. I will continue to read your publication.

To the Editor:

I noticed a mistake in your June 24 issue on p. 15. The mistake is under Boxscore of manned space flights. It indicates Maj. Gordon Cooper as a USSR candidate. I don't think that would make him happy.

K. A. Harris
Group Engineer
Program Plans, *Nike-Zeus*
Douglas Aircraft
Santa Monica, Calif.

To the Editor:

You are probably buried under tons of mail for this boo-boo, so here is my ½-oz. contribution.

In the June 24 issue you credit Schirra's and Cooper's flights to the Soviet Union.

R. B. Minton, Jr.
El Paso, Tex.

To the Editor:

It's bad enough that the United States is lagging behind Russia in Space Age achievements but to give them credit for two of OUR accomplishments, well . . .

Al Erxleben
Jacksonville, Fla.

To the Editor:

Let's give Gordon Cooper back his American citizenship!

Robert S. Duggan, Jr.
Atlanta

Done!—Ed.

Reliability Charts

To the Editor:

May we say thanks for the splendid treatment you gave MSFC's John Graham's reliability charts ("Where Components Must Be Improved," M/R, June 17, p. 40)?

We believe this is a significant service to component designers and manufacturers, and we appreciate your help very much.

Joe M. Jones
Chief, News Branch
Public Information Office
National Aeronautics
and Space Administration
George C. Marshall
Space Flight Center
Huntsville, Ala.

Valentina's 71 Hours

To the Editor:

In your article, "More Cosmonaut Trips Expected" (M/R, June 24, p. 14) you write conflicting statements concerning Miss Tereshkova's orbital flight.

In the first column on p. 14, you mention that she made 49 orbits. In the second column, however, you state she made 71 orbits. I presume this should be 71 hours.

Fred Lewis
Burlington, Vt.

Seventy-one hours is correct, as reported in the last paragraph of the article. —Ed.

Slash in Solids

To the Editor:

How long, O Lord, the shortsightedness of our powers-that-be in Washington!

Now they're about to cut two thirds of the funds for big solids—endangering the national future and penalizing companies that invested millions of their own dollars.

Fred Schwartz
New York, N.Y.

Astrolog Reprints

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Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

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Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

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Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

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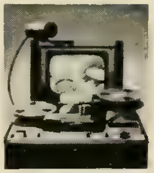

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The Countdown

WASHINGTON

AF Willing to Part with 260-incher

At a recent NASA meeting, Air Force officials offered to give the 260-in. solid motor program back to the space agency. AF feels it will have difficulty convincing the Dept. of Defense that the big solid motor has a mission; it would rather concentrate its funding on the 156-in. motor. NASA, however, has no Congressional authorization to engage in the program, at least during the current fiscal year.

ARPA Ponders Anti-ICBM HIBEX

Advanced Research Projects Agency may soon request proposals on a high-velocity kill mechanism known as *HIBEX*. Weapon would be an ICBM interceptor and reportedly would attack an incoming warhead earlier in its trajectory than is the case with *Nike-Zeus* or *Nike-X*.

Syncom II Due to Fly Next Week

NASA's *Syncom II* communications satellite is scheduled for launch from Cape Canaveral on July 23. Satellite will carry a new zinc-oxide battery to provide power for about 30 or 40 minutes in case of loss of the primary power system. It also will have a new apogee-kick motor developed by Jet Propulsion Laboratory.

Pace May Decide Fate of Bios

Dr. Nello Pace, recently named consultant to NASA Administrator James E. Webb on life science programs, will conduct a six-month survey of space agency activities in that area. Included will be a study of effectiveness of the life sciences organization and of how much duplication in space medicine is present between NASA and DOD. Big unanswered question is how the survey will affect the *Bios* satellite program. Decision as to whether or not to go ahead with the program had been expected in the near future, but the survey could delay it.

House Group Curious About Boosters

House Space Committee has finished work on the NASA authorization bill, but has yet some work to do. Chairman George Miller (D-Calif.) says the group still wants some questions answered. Among the subjects: the big booster program and astronaut remuneration.

INDUSTRY

Bids in on Unmanned Programs

Some 37 firms have submitted bids on a study of launch vehicle and propulsion systems for unmanned NASA space programs. Bids were due July 8 and contractor is expected to be selected in about a month. Manned Spacecraft Center has also awarded Avionics Division of Bell Aerosystems a contract to develop an electronic cylindrical rendezvous target-image generator.

ComSat Corp. Breaks the Ice

Communications Satellite Corp. has issued its first request for proposals on a study contract, sending the request to four companies—Bell Telephone Labs, Inc., General Telephone and Electronics Corp., IT&T and RCA. Award will be for a specific study of a multiple access system for *ComSats*. Reason for inviting just four firms to seek the negotiated, fixed-price contract is that ComSat Corp. wants it to be an extension of previous multiple access system work, and wants winner of the contract to be able to design a system embodying the chosen proposal.

Two-man Gemini Environmental Test

Garrett AiResearch will run a two-day test of the *Gemini* environmental control system at its Los Angeles laboratories later this month. Manned Spacecraft Center officials say two men will be sealed into the capsule.

Advanced Saturn Advances

Saturn V program took a forward step with award of three big contracts for facilities at Cape Canaveral. U.S. Steel Corp. received a $23,534,300 contract from Corps of Engineers for building the steel structures for the Vertical Assembly building, to be completed in 16 months. NASA signed an $11,225,459 contract with Ingalls Iron Works Co., Birmingham, Ala., for three launcher umbilical towers for *Saturn V*. And the Engineers awarded Blount Brothers, Montgomery, Ala., $8,069,000 for building foundations for the Vertical Assembly Building.

INTERNATIONAL

French Space Budget Reduced

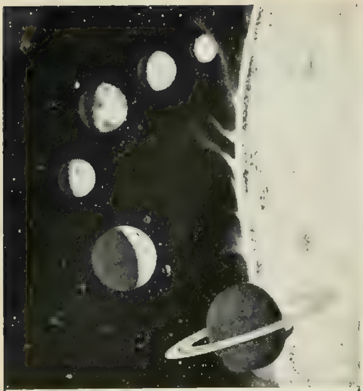
France's effort to step up space research work suffered a setback when Premier Pompidou trimmed 14% off the national space budget proposal submitted by CNES—the French Administration for Space Research. Proposal had been okayed by the Finance Department. French specialists fear the slash may endanger their expansion plans.

Test Rockets Reach Mach 12

At the Ile du Levant launch center, two French *Bérénice* rockets are reported to have reached Mach 12 and altitude of about 60,000 ft. *Bérénice* is used for testing re-entry cones and could also be operated as a probe that could carry 60 kg to an altitude of 1,000 kilometers.

Couple Baby-Sits with Blue Streak

A complete *Blue Streak* first stage of the European Launcher Development Organization's launcher vehicle is about to arrive in Australia for trials at Woomera after a five-week sea voyage from London. A husband and wife team "baby-sat" with the rocket to insure a full internal head of nitrogen so the missile didn't collapse.



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SPACE AND INFORMATION SYSTEMS DIVISION

North American Aviation

The *Missile/Space* Week

Republic To Develop AOSO

Republic Aviation Corp. has been selected by NASA to develop the *Advanced Orbiting Solar Observatory (AOSO)*.

The Value of the Phase I contract is expected to be about $5½ million.

Phase I will require about one year for completion, will include detail design, systems engineering, reliability assessment, limited hardware development of critical systems and components and trade-off analysis.

A breadboard model of the control and data-handling systems, and development of an engineering model of the sun sensor are included in the contract.

Divided into three phases, the development plan calls for prototype development and construction in Phase II and flight model construction and test in Phase III. Launch of the first spacecraft is planned for late 1967.

The solar observatory series began with the successful launching of the *Orbiting Solar Observatory I* March 7, 1962. It transmitted useful data during 11 weeks of continuous operation and several additional weeks of intermittent operation. Seven more of these spacecraft are planned for launch before the first *AOSO* goes.

AOSO will differ from the current solar observatories in that it will have greatly increased pointing accuracy, control flexibility, data handling capacity and experiment instrumentation.

Field-Astronaut Deal Dies

Objection in Congress and NASA sluggishness have apparently combined to prompt Field Enterprises Educational Corp. to withdraw its $3.2-million offer for the personal stories of the first 16 U.S. astronauts.

A top Field official said after repeated visits to Washington that "it would take longer to get a NASA-approved contract than will be needed to get a man on the Moon."

Field Enterprises was to have handled book, magazine, newspaper, television, radio and motion picture rights to the astronauts' stories.

Rep. John W. Wydler (R-N.Y.), a member of the House Space Committee, was on record opposing the transaction. He had asked NASA Administrator James E. Webb not to approve the Field contract, reasoning that sale of astronaut stories should be confined to events not connected with their duties as astronauts.

Shots of the Week

The Soviet Union has announced the completion of a series of space exploration shots in the Central Pacific during June and early July. Official news agency, Tass, stated that the "flight of the rockets and operation of all their systems proceeded in exact conformity" to plans. No further information was released on the shots.

Other shots of the week:

- The Navy sucessfully fired a *Polaris A3* from a land-based launch pad at Cape Canaveral July 3. The missile flew 1,500 miles down the Atlantic Missile Range.
- An Army *Nike-Zeus* anti-missile missile performed successfully at White Sands Missile Range, N.M., in a July 3 test studying precise control of the missile by ground equipment under "severe" conditions. Information gained is to be applied to *Nike-X* development.
- NASA launched a two-stage *Aerobee* sounding rocket July 9 from Wallops Island, Va. It's 164-lb. instrumented payload relayed information on electro-magnetic noise found at altitudes of 37 to 140 miles.
- An Air Force *Minuteman* underwent its 11th launch from Vandenberg AFB, Calif., July 5 at the hands of a Strategic Air Command crew. Launch provided data for evaluation of missile sub-systems, and validated improvements in components of the operational missile.
- An Air Force *Atlas* was successfully fired from Vandenberg AFB, Calif., July 3.

SFC Contracts Total $1.4 M

The Marshall Space Flight Center has awarded contracts totaling $1,420,957 covering four projects under way at the Center.

Martin Marietta Corporation's Baltimore Division received a contract for $826,990 to provide five horizon sensors and two sensor power supplies for the *Saturn I* space rocket and to design, develop and produce a new type of horizon sensor for use in the *Saturn V* instrument unit.

Space Technology Laboratories of Redondo Beach, Calif., will conduct a comparative design study of modular stage concepts for lunar supply operations. The STL contract is for $249,103.

General Electric Co. received a contract for $96,320 to perform research and development in fluid amplifiers and logic elements and systems and to determine the feasibility of using the technique in designing future space vehicle systems.

Two contracts were awarded for studies concerning cryogenic insulation. A $144,304 contract went to the Martin Marietta Corp. and one for $104,240 went to North American Aviation.

EG&G Gets $32-million Pact

The Atomic Energy Commission has extended its contract with the Boston firm of Edgerton, Germeshausen and Grier, Inc., for R&D work in connection with AEC programs. The FY '64 contract is worth $32 million, compared with the $25-million contract for FY '63.

Included under the pact are such projects as *Rover*—the nuclear rocket program—and all nuclear warhead developments. EG&G produces the timing, firing and instrumentation systems for all nuclear tests, as well as producing components for electronic, laser and photographic systems.

Telstar Telecast Killed

The French government threw the switch blacking out European reception of what was to have been a live transatlantic television show relayed by *Telstar II* July 10. The CBS-produced "Town Meeting of the World" would have coincided with the first anniversary of the first *Telstar* transatlantic broadcast.

The French refused permission to use a ground station needed to complete the relay circuit, possibly because of "controversial" program matter on the European Common Market.

AFSC Pinpoints Management

Definition and assignment of management responsibilities for Air Force Systems Command divisions have been clarified and sharpened to improve AFSC operation.

The new "Lead Division" policy pinpoints management responsibilities for all AFSC programs in specific functional areas, and updates all mission statements.

According to AFSC, the new regulations will insure that command-wide capabilities are properly used in the planning and conduct of command programs.

AFSC took the step especially to handle situations where two or more separately managed programs under several AFSC divisions must be combined to achieve a larger program objective.

The new AFSC policy calls for one of the divisions involved to be designated the lead division, and it therefore assumes the leadership of the combined program.

Princeton Gets NASA Grant

A $625,000 NASA grant announced by Princeton University last week is earmarked to established a graduate-level basic research laboratory in liquid and solid propellant rockets, combustion fundamentals and nuclear and electric space propulsion.

The new facilities will be part of the Guggenheim Laboratories for the Aerospace Propulsion Sciences.

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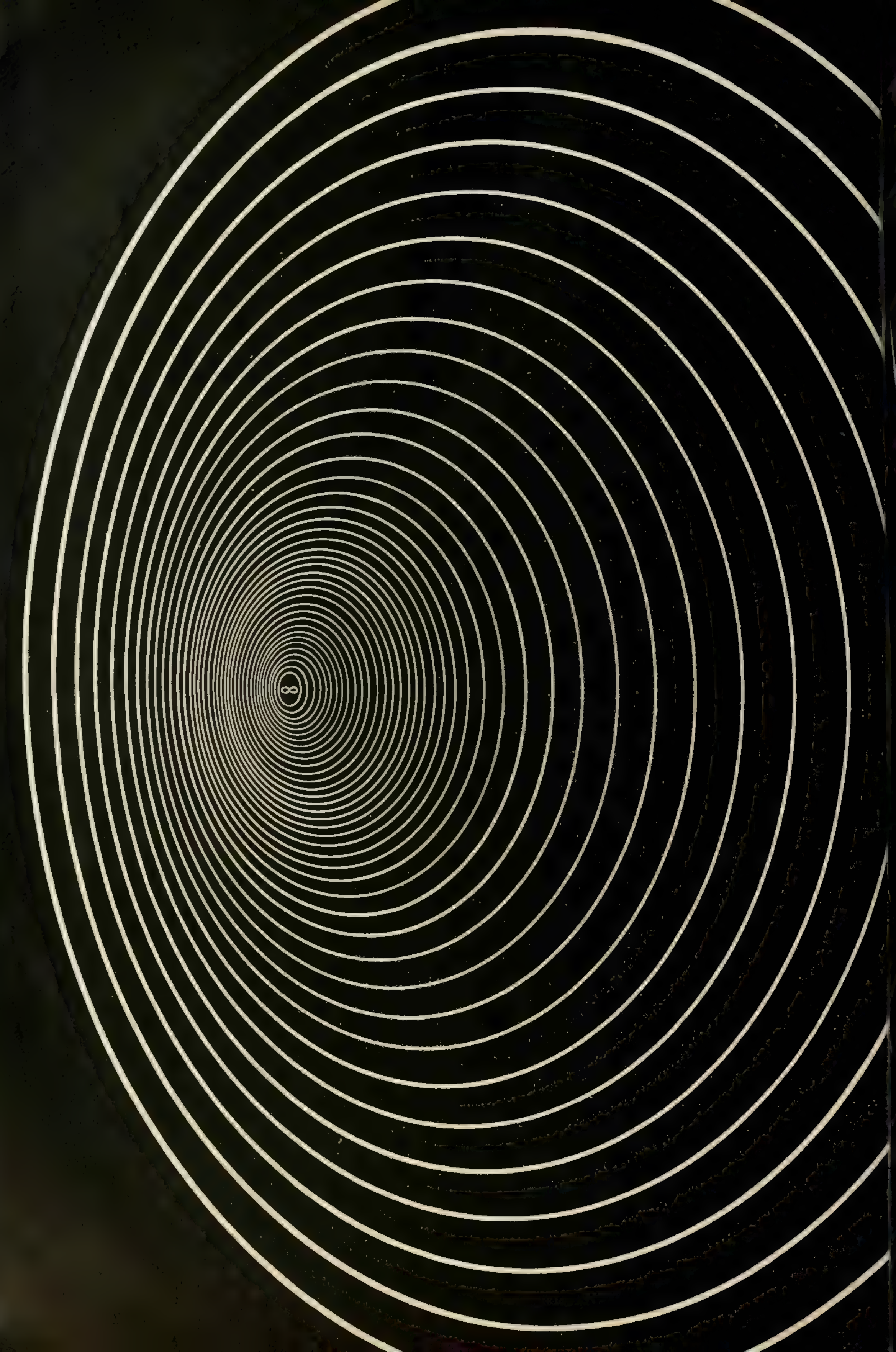

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In 'no new starts' year . . .

MOSS Planning Faces Slippage

Little or no funding expected in FY '65 budget; election-year economics, lack of decisions are factors

by Hal Taylor

THE TIMETABLE for a U.S. *Manned Orbiting Space Station* program apparently is slipping into Fiscal 1966.

An Administration official reports there will be "small, if any" funding for the program in the Fiscal 1965 budget, now in the preliminary preparation stage. "Heavy development funding is far more likely in Fiscal '66," he added.

The expected delay probably will kill NASA plans which called for selection of a *MOSS* concept and award of a preliminary design contract in November or December, 1963.

It probably will also mean that no funding will be available in the next fiscal year for space agency plans for an "extended *Apollo* spacecraft." Officials of the Office of Manned Space Flight want the modified *Apollo* as part of their manned lunar landing program, but they admit that it could serve as an interim space station.

With its large propulsion package, it probably would also fulfill the Dept. of Defense need for a spacecraft with orbital change capability.

The agency is, however, going ahead with plans to select a contractor within a month to study the extended *Apollo* concept.

- **Holdups**—The delay in the space station program stems from the Kennedy Administration decision to hold the line on next year's election-year budget. Officials now refer to Fiscal '65 as the "no new starts" year.

It is also being hamstrung to a certain extent by a lack of major program decisions—including which agency will manage it as well as establishment of a development schedule.

It is expected that a development schedule will be settled by the end of this year, as the Fiscal '65 budget is finalized, but one official said a decision on management is "some time off."

One major decision—that there will be only one national *MOSS* program—has been made informally by Secretary of Defense Robert S. McNamara and NASA Administrator James E. Webb.

As a result, meetings are being held to discuss the program in the joint NASA-DOD Aeronautics and Astronautics Coordinating Board.

The Administration foresees the program as the first truly cooperative U.S. space effort. While only one agency will manage the program, funding would be provided by both.

One compromise being considered would let NASA build the station and make DOD responsible for the logistic resupply vehicle.

- **NASA program**—The space agency's schedule called for the completion of four separate station studies late this year. At that time, the selection of the desired mode was to be made and a preliminary design contract awarded.

The design phase was to last 12 months. A hardware development contract—if NASA were told to develop the station—could have been awarded in Fiscal '65.

With the expected delay in the program, the space agency probably will put off a decision as to a preferred concept until 1964. NASA officials still lean toward the development of a small station first, with the 36-man station coming later in the decade. This puts the six-man *Manned Orbiting Research Laboratory (MORL)* and the extended *Apollo* spacecraft in the forefront.

In the larger-station area, NASA is studying a large zero-g station and a large rotating station concept.

- **AF program**—The Air Force effort thus far has been primarily in-house, and its first attempt to award study contracts to industry may be stymied by a lack of funds.

It has requested industry to submit proposals for three parallel four-month studies of space station concepts later this month. It is still not clear whether funds will be available for the studies.

There are two possible sources for the money: approval by DOD of a $1-million reprogramming or transfer of some funds budgeted for the Office of Secretary of the Air Force Eugene Zuckert.

AF announcement of the intention to solicit proposals means that a request for the funds has been made, but AF spokesmen refused to say whether it has been approved. ∎

Shillelagh Can Be Infantry Weapon

NEWLY RELEASED PHOTO of Shillelagh surface-to-surface guided missile being developed for the Army by Aeronutronic Division of Philco Corp., a subsidiary of Ford Motor Co. Weapon will provide ability to kill tanks with heaviest known armor. It has been regarded strictly as a vehicle-launched missile, but last fall it was successfully fired from a lightweight, open-breech infantry launcher.

Crackdown on reprogramming . . .

NASA Budget of $5.2 Billion Okayed

by Heather M. David

THE HOUSE of Representatives is expected to pass the NASA Fiscal Year 1964 authorization bill with a cut of $488.9 million in the agency's request. This brings the total amount authorized to $5.2 billion.

House Space Committee Chairman Rep. George Miller (D-Calif.) said the committee was well prepared to resist any attempts from the floor to make further changes in the bill, since the many weeks of detailed hearings have prepared it to be "well on the offensive."

The committee last week acted upon recommendations of the third of three subcommittees, the Applications and Tracking and Data Acquisition group chaired by Rep. Ken Hechler (D-W. Va.). This subcommittee recommended a cut of $96.5 million, which the full committee reduced to $95.5 million, or 9.25% of the $1,032,803,000 request handled by the subcommittee.

Earlier, the committee acted upon reports by the Manned Spaceflight and Space Sciences subcommittees. It trimmed the Manned Spaceflight budget by $259.2 million and the Space Sciences request by $136.2 million. In a surprise, it added $2 million which NASA had not requested for further development of a high-energy propulsion program.

- **Tighter controls**—NASA's reprogramming activities will be severely curtailed if the House and Senate go along with the committee's bill. It requires that NASA get prior approval from the committee before using any other funds for programs or items deleted by committee, or for any program in excess of the amount authorized when the original request was specifically reduced. The NASA administrator must seek approval from the committee for any new programs which were not presented in the original budget. The bill also calls for a three-year expiration period for funds appropriated but not spent.

As expected, the $63.7-million requested for meteorological satellites was passed without any reduction by the committee. However, a $7-million cut was made in the $40-million advanced synchronous communications satellite program. The committee reported it felt that this amount, requested for *Atlas-Agena* launch vehicles and spacecraft not scheduled for delivery until FY 1966 or 1967, could be deferred until then without affecting launch schedules.

The House committee also endorsed a Department of Defense suggestion for obtaining tracking ships for *Apollo* launches. While NASA had asked for $90 million to modify three ships for use on a full-time basis, DOD officials testified that for $80 million it could modify four existing ships and equip one new vessel with funds to be transferred from NASA to DOD. The committee therefore voted a $10-million cut in NASA's request, and stipulated that the money be used as DOD suggested.

While the tracking and data-acquisition portion of the budget was cut by $14.8 million, there were no reductions in those phases which directly support manned spaceflight.

- **Knocked out**—Advanced applications satellites funding, for which $1 million had been requested by NASA, was totally deleted. The committee report said this was "in view of the broad interest of scientists everywhere to exploit satellite applications."

A $3.5-million item for industrial applications, which had been cut by $1 million by the subcommittee in a close vote, was restored to its full amount.

NASA's administrative operations budget for these operations was cut by $52.1 million. The largest item in this reduction is $25 million for personnel compensation and personnel benefits.

Hechler told M/R the committee had found that the average GS grade in NASA is a 10, which is higher than any other governmental organization engaging in R&D activities. With this in mind, he said, the committee felt some reduction could be made.

- **Further cuts**—Other administrative operations items cut by the committee were: travel and transportation of persons, $2 million; transportation of things, $789,000, rent, communications and utilities, $2 million; printing and reproduction, $250,000; other services, $11.7 million; supplies and materials, $3.96 million; equipment, $6.4 million. ■

Joint Committee Gets More Control of AEC

THE JOINT Congressional Committee on Atomic Energy will hold intensive hearings starting early next year on atomic weapons and space systems as a result of new powers voted it by Congress this week.

Beginning in January, 1964, all atomic weapons, missile and rocket propulsion reactors, satellite and small power sources must receive Congressional authorization before funds for them can be appropriated to the Atomic Energy Commission. These items have been lumped in a category of "operating expenses," comprising most of AEC's budget, which until now did not require Congressional authorization.

The bill will give Congress a much bigger say in the initiation of all atomic programs, Rep. Chet Holifield (D-Calif.), vice chairman of the Joint Committee, told M/R. "There's been a need for close and more intensive scrutiny of various R&D programs," he said.

Before passage of the bill, which amends the Atomic Energy Act of 1954, these portions of the budget (this year more than 90%) received only a few days of examination by the Appropriations Committee and were passed on with rather superficial reductions. This year, the budget requested by AEC is more than $2.896 billion, of which only $216 million received authorization action.

Until now, Congress had authorization control only over construction, cooperative programs with West Germany and Euratom (European Atomic Energy Community), the cooperative power reactor demonstration program, and spectral shift power reactor program. Starting next year, the entire AEC budget comes under the Joint Committee's control.

None of the missile/space construction projects in the current authorization were cut. These are: atomic weapons, $30.68 million; SNAP development and test facilities, $500,000; support facilities for advanced space power systems, $1.8 million; Project Rover, $3 million. By contrast, program amounts for outer space activities are $213.7 million, and military programs, $118.5 million. However, the committee will not have jurisdiction over the rest of the FY '64 budget unless supplemental appropriations are requested next year.

NASA changes plan . . .

First Unmanned Gemini Flight Will B

No slippage seen in planned December launch, originally set to be ballistic shot; firing is designed to test structural integrity of Titan II and capsule, with both going into orbit

HOUSTON—NASA's first *Gemini* flight will be orbital instead of the ballistic shot called for originally. The orbital mission will test the structural integrity of the *Titan II-Gemini* combination.

The change in plans should not delay the first launch, since the first unmanned capsule will be ready on schedule in December, the program manager says.

Charles W. Mathews, acting project director, expects the first flight capsule to reach Cape Canaveral within six weeks. It is one of two flight models now in the McDonnell Aircraft white room.

The first *Gemini-Titan II* static tests are nearly complete at Martin-Baltimore, and the rocket will soon be shipped to the Cape for static firing of its engine.

The first flight article will test structural compatibility of the *Gemini* and the *Titan*. A minimum of working systems will be placed on board the *Gemini* for the first flight.

The capsule will be heavily instrumented, however, for acceleration, vibration, temperature, and acoustical measurements. It will carry a beacon to allow network tracking.

Special measurements will be made in the pressure compartment or cockpit and beneath the heat shield and inside retro-re-entry compartments, Mathews said. These checks will be carried out as a result of mishaps in the early *Mercury* program, when pressures between spacecraft and atmosphere equalized in unexpected fashion.

- **Initial orbit**—The first flight will orbit the *Gemini* spacecraft, although it will not be recovered. Mathews said the structural model might remain in its 100-180-statute-mile orbit as long as a week before orbital decay and burnout.

Second flight will be ballistic, with water landing by parachute. All systems, including the fuel cells, will be flown for validation. A "mechanical man" aboard will simulate oxygen consumption and output of carbon dioxide. Time: summer, 1964.

In addition, the machine will carry a taped program activating relays to perform the same switching and control maneuvers expected of an astronaut, including retro and re-entry maneuvers, and separation from rocket and adapter section.

Abort maneuvers—including hatch activation and ejection of astronauts—have successfully passed ground tests. Two weeks ago at China Lake the dummy astronauts survived ejection at maximum drag, about 600 mph. Last week, Mathews said, dummies survived a simulated pre-launch abort. Seats containing dummies were fired out of a boilerplace craft on a tower 150 ft. tall. They were blasted 300 ft. into the air and recovered by parachute without damage.

- **First men up**—Mathews expects the third *Gemini* shot late in 1964, with two astronauts aboard. The shot will not be an open-ended flight, although Mathews declined to set an optimum number of orbits. Purpose of the flight will be to allow systems to stabilize in operation, which is an unlikely event in one orbit.

Paraglider problems are "nothing

MSC Plans Five Apollo Landings

HOUSTON—Manned Spacecraft Center plans at least five lunar landings as part of Project *Apollo*.

MSC announced the mission schedule as part of a request for proposals seeking a study "to determine the optimum measurements, experiments and geologic studies to be made on the lunar surface." Proposals are due July 19.

The first two landings will allow two astronauts only four hours of working time on each landing. Landings three and four will allow the astronauts a full day of work, minus sleeping time. On the fifth landing, the astronauts and their Lunar Excursion Module (LEM) will spend a week on the Moon's surface. If all goes well on the fifth mission, the week-long stay will become standard for a Moon landing.

Scientific equipment carried out of lunar orbit and down to the surface can weigh 215 lbs. Astronauts can carry 85 lbs. of scientific payload back to the mother ship.

Dr. John Dornbach, lunar cartologist with MSC, said the study would allow astronauts best use of their limited time on the lunar surface. Study of astronaut tasks covers eight months.

Most of the scientific equipment should be carried outside the landing vehicle.

Mission success hinges on verification of engineering properties of the Moon, bearing strength, slope trafficability, electrical and thermal properties, and hazards to men.

Fundamental knowledge tasks cover measurements and sampling of rock types, mineral content variations, absolute age of formations, method of formation for surface features, seismic activity, magnetic field, horizontal and depth temperatures, gravity variations with time and place, minerals for possible extraction of water and other resources, and a search for compounds of possible significance to the question of life's origin.

bital Shot

Warren Burkett

really too basic," Mathews said. The area of design having the highest number of failures is the sequencing; this is due to failure of the pyrotechnics to fire properly. *Gemini* officials scheduled special meetings on the pyrotechnics problem at MSC this week.

Mathews refused, however, to commit the program to use of the paraglider during the summer of 1965, when it is scheduled to come into the program. Parallel development of both paraglider and parasail landing systems will continue unchecked. *Gemini* officials reopened basic research and development on the paraglider and its materials in order to get a better performance than the original glider was able to deliver. The changes in the research were designed to make the flareout and touchdown maneuvers less critical.

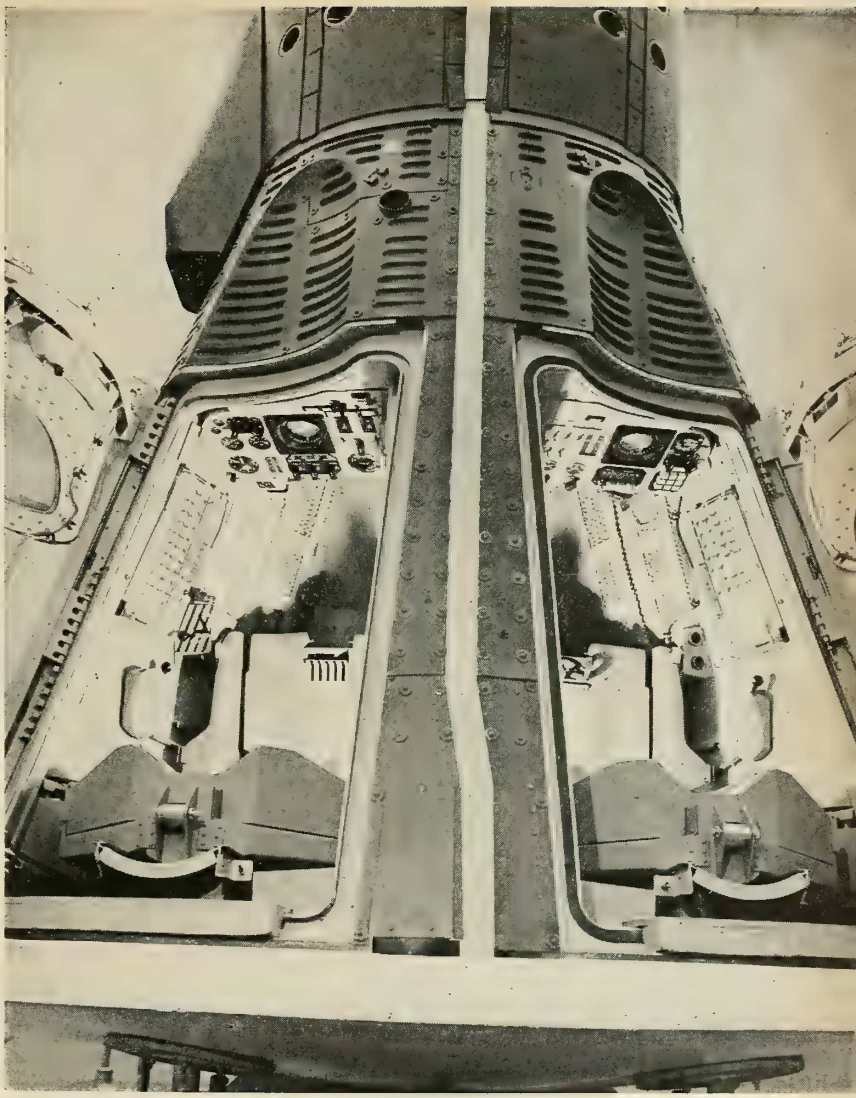
Two half-scale *Geminis* with one pilot each will undergo tow-tests this fall at Edwards AFB, Calif., to prove out landing manuevers. *Gemini* models will be towed off the ground to about 2,000 ft. Later, full-scale vehicles will be dropped from C-130's at about 50,000 ft. for unmanned, radio-controlled test of paraglider deployment and landing.

- **Rendezvous in '65**—Long-duration and rendezvous maneuvers will be interleaved, Mathews said, starting about the middle of 1965. This would be in the neighborhood of the second or the third manned flights, but "it won't work out quite that way," Mathews said.

Control over space flights should have shifted to Houston's Integrated Mission Control Center (M/R, July 8, p. 32) long before rendezvous practice, Mathews said.

Philco's Western Laboratories should have the control center ready for practice operations by August, 1964.

Arrival of Col. Dan McKee and the 12 Air Force men assigned to Manned Spacecraft Center in the first contingent is expected the first week in August. McKee now heads the Air Force *Gemini* program.



CLOSEUP OF ASTRONAUT hatches and seats in Gemini engineering model.

Mathews plans a variety of rendezvous maneuvers for the *Gemini* spacecraft. There will be orbital rendezvous with an instrument package containing only beacon lights and radar to give maneuver and computer training and simulate rendezvous with satellites. The package will be carried into orbit by *Gemini*. Pilots will decide how near the instrument package they want to maneuver.

Agena rendezvous plans are still on the books because of the need to develop orbit change techniques. *Gemini* crewmen also will fly simulated *Apollo* mission profiles. Mathews sees a large role for *Gemini* as a trainer for *Apollo* flights.

- **Titan dividend**—*Gemini* received a payload bonus because of improved operation of the *Titan II* during its development, Mathews said. But he would not say what this was in pounds. Ninety percent of the "pogo" problem was removed from *Titan* after the tankage was overpressurized by feeding back exhaust gases. Vibration is now at 11 cycles per sec.; although tests will be run at Ames this summer to see if this blurs vision or complicates the pilot reactions, Mathews wants all of it eliminated.

The project manager praised Martin's work in bringing the *Titan* along to man rating. Air Force test shots are now carrying abort sensors planned for the manned *Titans*. "Pogo" vibration occurs 80 to 100 secs after liftoff; this is the critical period. ■

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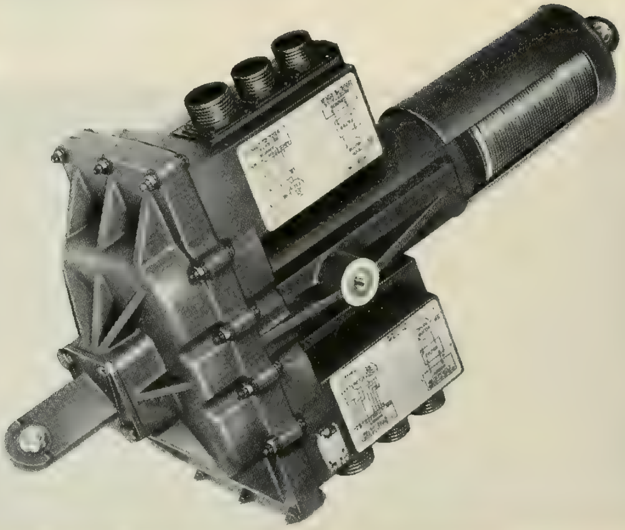

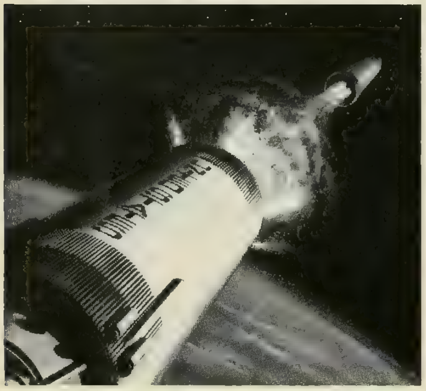

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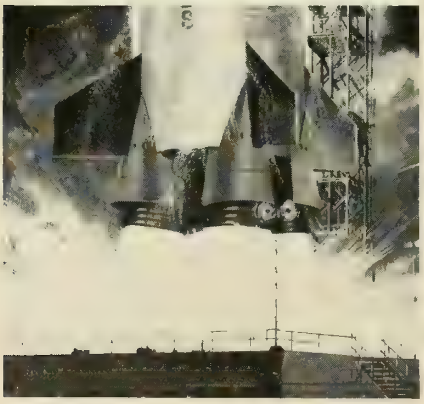

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echnical Countdown

ASTRONAUTICS

eteor Simulation Vehicles Being Readied

NASA's Langley Research Center will study low-velocity eteor effects optically using two new research rockets, a odified *Trailblazer II* and a modified *Nike-Cajun*. The st will drive a re-entry pellet from an Atlantic Research rp. velocity package into the atmosphere from 215 km. itude at 20 km./sec. The *Nike-Cajun* velocity package, veloped by Zimmey Corp., will return two pellets Earth- rd 20 sec. apart at approximately 11 km/sec. from alti- des of 130 km. and 155 km., respectively.

eceleration Studies Underway at Goodyear

Goodyear Aerospace Corp. will examine deceleration d stabilization systems for advanced re-entry vehicles der a $1-million contract from the Flight Accessories b., Aeronautical Systems Div., Wright-Patterson Air rce Base. In the first phase, Goodyear will research and ssibly develop various types of parachute and balloon-like celeration devices up to Mach 7 to determine their limita- ns. The firm recently received a contract to incorporate "Ballute" (balloon-parachute) decelerator in the *Gemini* psule. The new contract calls for studies at speeds higher an those anticipated in the *Gemini* program.

ELECTRONICS

eactor Power Chosen for DUSS

Nuclear power equipment to electrify the U.S. military's eep Underground Support System will be developed by estinghouse Electric Corp. under a recently announced ir Force contract. Sponsored by the AF Special Weapons enter at Kirtland AFB, N.M., the project calls for selec- on and design of a suitable reactor-driven generator within x months. Presumably, the electrical generating systems ill be built and installed in the underground command osts during the 1964-65 time period.

uperconducting Magnet Work Funded at Avco

Research into both advanced superconducting magnets nd radiation shielding through such systems is under way t Avco-Everett under two contracts totalling $192,283 from ASA's Marshall Space Flight Center. The radiation con- act calls for exploring the feasibility of wrapping space ehicles in the magnetic field of a superconducting magnet o ward off ionizing radiation. The second contract for al- ost an equal amount is directed toward studies of coils nd coil materials.

plice Cases To Go Into Minuteman Silos

The Air Force is purchasing $1.3 million worth of revo- utionary splice-cases and pressure-component assemblies rom American Machine and Foundry Co. for linking under- round communication cables at hardened *Minuteman* CBM sites. The contract calls for 4,000 of the basketball- ize spherical splice cases and 2,000 pressure assemblies. The cast iron splice case has 33% fewer parts than con- entional cylindrical interconnecting cases commonly used o join large underground cables.

Second ARIS Nearly Ready

The U.S.A.F.S. Gen. Hoyt Vandenberg, second of two Advanced Range Instrumentation Ships built by Sperry-Rand for the Air Force, will be dedicated July 18 at Baltimore.

Antenna To Ride On 80 Rubber Wheels

An 85-ft.-dia. "portable" radio telescope will be built by Blaw-Knox Co. for the National Radio Astronomy Observatory at Green Bank, W. Va. While the dish itself will duplicate a similar fixed antenna already built for the station by B-K, the entire new assembly will ride atop a triangular-base steel structure mounted on three rubber-tired dollies. Built to accommodate variations along the path over which the big structure will be moved by tractor, one dolly employs eight axles and 32 wheels; the other two are provided with six axles and 24 wheels each. Dish mobility will permit interferometric measurements with the two dishes.

ADVANCED MATERIALS

High-Temperature Test Equipment at Martin

Martin Baltimore engineers are testing non-metallic materials at surface temperatures up to 5000° F. in a company-designed and developed arc-image facility. The test setup is designed to determine the degree of error expected between a pyrometer reading and the actual surface temperature. The device consists of an arc lamp, two mirrors, two pyrometers, two whirling discs and a specimen holder. The test unit can be modified for temperatures up to 10,000° F. as the state of the art advances in materials. Current items under test include ceramics, graphite, nylon, epoxies, phenolics and other compounds considered for heat shields.

Encapsulation Technique Perfected

A new process that encapsulates individual fibers and particles in plastics is past the pilot-plant stage at National Lead Co. Each fiber or particle is enveloped by forming the plastic directly on the surface from ethylene gas or a similar olefin. The gas is introduced to a polymerization zone created by forming catalyst sites on the substrate. The firm is producing encapsulated cellulose and glass fibers under the trademark "Nalcon." Other materials amenable to the encapsulating process include carbon black, asbestos, mineral wool, metal powders and salts.

Flame Heated Thermionic Converter Successful

A prototype hydrocarbon-fuel thermionic converter has been operated for more than 2,000 hrs. in vacuum, producing a total of 14 kw-hrs. of electric power. The feasibility system, being developed by Thermo Electron Engineering Corp. under U.S. Army Signal Corps and American Gas Assn. contracts, makes use of the combustion heat of fuels such as natural gas, propane, or leaded gasoline to drive a thermionic converter. The present burner produces temperatures above 1,500° C. and heat flux densities in excess of 50 watts/cm^2. Enclosures of pyrolytically deposited silicon carbide are used to protect the converters from oxidation.

SPACE MEDICINE

Bioelectrogenesis at General Electric

Enough electrical power to handle a 500-kc transmitter has been drawn from a live rat in experiments at GE's Space Science Labs, Valley Forge, Pa. No biological functions were disturbed in the process which involved planting electrodes subcutaneously in the rat's body and in its peritoneal cavity. Maximum power of 155 microwatts was observed under a load of 500 ohms at 0.23 volts. Development may lead to planting electrical devices in humans to regulate functions or report reactions without using batteries.

AN M/R SPECIAL REPORT

Critical Design Phase Ending on Lunar Excursion Module

Major system concepts now frozen; first mockup tests under way at Grumman; fuel cell, cryogenic tankage only big subcontracts left

by Michael Getler

HOUSTON—NASA-industry effort to design the spacecraft that will carry two U.S. astronauts to and from the lunar surface is now emerging from what is probably its most important but least glamorous phase—detailed design studies, initial weight-vs.-reliability trade-off decisions, and subsystem specification writing.

Seven months after selection of the Grumman Aircraft Engineering Corp. as prime contractor for LEM, NASA engineers at the Manned Spacecraft Center here report the major concepts and system design "are just about frozen."

Design study will continue in some areas for several years. Vital inputs concerning rendezvous and in-flight test and repair capabilities will come only after *Gemini* experience in 1964-65. Breakthroughs in knowledge of the nature of the lunar surface could cause a major redesign of the LEM landing gear, which has already undergone one significant shift.

But in contrast with the past and continuing perplexity of paper studies for this task, the first trio of wooden mock-ups now line the hangar bay at Grumman's Bethpage, N.Y., plant. In these models, engineers sit in wooden flight chairs and visually guide another wooden model of the *Apollo* command module into its LEM docking hatch.

- **Major subcontracting complete**—With approval late last month by NASA of RCA's $40-million role as a major LEM subcontractor for certain electronic subsystems (radar, communications, and portions of in-flight and ground testing, and some stabilization and control—S&C—units) plus engineering support, the LEM industrial team of major subcontractors (M/R, Feb. 4, p. 10) is virtually complete.

Two other sizable awards remain—a contract for development of the fuel cell for LEM, which will deliver primary on-board power, and the award for a single cryogenic tankage system that will supply oxygen for both the fuel cell and crew support.

The fuel cell contractor has been selected and announcement is "imminent." Completion of all major subcontracting and negotiations is expected by fall.

LEM should put the U.S. on the Moon by 1968, though "within the decade" is the official NASA prediction.

- **Mission profile**—Its journey starts aboard a *Saturn V* booster launched from the Atlantic Missile Range into Earth orbit. LEM will be tucked beneath the *Apollo* command and service modules (CM & SM). *Apollo* spacecraft weight at lift-off will be about 85,000 lbs. LEM accounts for 25,000 lbs. The three-man crew will ride in the CM at launch. The LEM cabin is not "man-rated" for Earth launch operations.

After in-flight and ground-directed checks in Earth orbit, the *Saturn's* third-stage (S-IVB) engines will be re-started, injecting *Apollo* and the stage into the lunar trajectory.

During early stages of the translunar flight, after passage through the Van Allen radiation belt, a transpositional docking maneuver will take place. Pyrotechnic devices will separate the CM & SM from the LEM and S-IVB. Using reaction control system (RCS) jets, being developed by Marquardt Corp., the attached CM & SM portion will rotate 180 degrees in a free-fly maneuver, approaching the LEM docking interface in a manner similar to the *Gemini-Agena* maneuver.

The unmanned portions of the vehicle, LEM and S-IVB, will be rate-stabilized, also in similar fashion to *Agena*, and may also have some degree of attitude stabilization, depending on mission plans.

The CM will dock "nose first" to the top docking hatch of LEM. After docking, pyrotechnic devices (probably shaped charges for large sheet areas and explosive bolts for the discrete attachments, the same type used for the escape tower) will separate LEM from the S-IVB stage adapter section.

The *Apollo* SM engine will then be used for mid-course corrections. Since the S-IVB will be in essentially the same trajectory, NASA is also studying possible changes in velocity associated with altering either section.

- **Lunar approach**—*Apollo* will follow what is described as a "free-return" trajectory, which is not as simple as the name implies. With this maneuver, if the spacecraft approaches the retro-fire point to enter lunar orbit but does not fire the SM engine, it can continue around the Moon, and, with the aid of the RCS, get back safely to pre-determined Earth recovery areas.

Throughout the *Apollo* and LEM flight plans, NASA engineers point out, every effort is made to use the natural capabilities of each trajectory chosen, each step becoming both more advanced and more precarious.

After a decision is made to enter

TRIO OF FIRST LEM face mockups lines Grumman hangar rea. Center mockup is being used for crew-transfer-after-docking tests, also has favored 45-degree canted window arrangement. The vehicle is slated to land two men in the Moon in 1968.

unar orbit, the retro-fire point will be eached on the back side of the Moon, nd the SM engine will brake *Apollo* nto a nominal 100-mi. two-hour cirular orbit.

While in lunar orbit, two astronauts vill enter LEM and perform in-flight hecks. LEM will land near the lunar quator on the side facing Earth. This vill facilitate communications with arth stations. Roughly 90° from the hosen landing area, LEM will separate rom the CM & SM at about 5 fps and egin a maneuver—using its descent ngine facing away from the Moon— o put it into a highly elliptical equieriod orbit.

The closest approach to the lunar urface in this orbit will be about 50,000 t. At its highest point, LEM will be onsiderably beyond the 100-mi. CM ltitude. The LEM and CM orbits interect, however, facilitating join-up if a ecision is made not to land.

With this kind of orbit, which can e maintained for more than one pass round the Moon, the crew will exerience an order-of-magnitude imrovement in site reconnaissance before nding (they will have a Kollsman nstrument Corp. 3X telescope on-board aid in site determination). Also, EM and CM will be in visual contact t all times in this orbit.

• **LEM descent details**—From the qui-period orbit, the LEM crew will ly heavily on the widely throttleable over a thrust range from 1,000-10,000 s.) descent engine and the RCS to get onto the lunar surface.

NASA has awarded parallel developent contracts to the Rocketdyne Div. of North American Aviation and to the Space Technology Laboratories subsidiary of Thompson Ramo Wooldridge, Inc. for this engine (M/R, June 3, p. 24). Selection of the winning design will probably come next summer.

The descent engine will burn continuously from about 50,000 ft. to a point a few feet above the surface, but at widely varied burning rates and at different engine orientations.

LEM descent will be automated (for more efficient fuel management) to a point about 1,000 ft. above the surface, where the craft will hover and shift to pilot control for the final let-down. NASA points out that the last 1,000 ft. could also be negotiated automatically, using the inertial measuring unit (IMU) and landing radar.

The landing radar will be used to update the IMU at about 20,000 ft. for accurate control of the flare maneuver, and will also be used as needed in this manner before the final control transition and hover.

LEM will be able to hover with some forward velocity to pick the best landing site, using the RCS to change pitch and direction. To approach setdown, the descent engine must be able to throttle below the effective weight of the vehicle on the Moon. The engine will be turned off a few feet above the surface, land with a near-zero velocity, nominally 10 fps vertically and 5 fps horizontally.

The entire descent from lunar orbit to the surface will take about 2½ hrs., with the final descent from 50,000 ft. lasting less than 10 min. The LEM mission is designed for a 48-hr. separation from the CM, with about a 24-hr. stay on the lunar surface.

• **Moon surface uncertainty**—Composition of the lunar surface is still a matter of conjecture. Many observers believe its nature will be uncertain until someone actually sets foot on it. However, at this stage, NASA reportedly has assumed that the lunar surface cannot support as much weight as was originally suggested in the LEM RFP's. As a result, design of the landing gear has changed significantly.

While Grumman originally favored a relatively small-radius, five-leg fixed gear, they will now go to a deployable (while in translunar flight) four-leg gear, which is said to offer more flexibility and a larger radius.

The gear, to be built by Grumman, is described as a space-frame structure with discrete energy-dissipating rather than energy-absorbing shocks. The gear will have about a 30-ft. spread. The five-leg version had a spread just over 20 ft. Each leg will have a 3-ft.-dia. bearing pad at the foot, with a crushable structure on the bottom for energy dissipation. Gear radius and retraction techniques could undergo minor changes.

LEM is being designed to a lunar surface model of locally deep dust deposits which are probably only inches thick in large areas, covering a rock/froth-like substance. The model assumes a nominal 5° terrain slope. Superimposed on this, NASA reports, is the requirement to handle a 2-ft. difference in height between opposite legs of the LEM gear.

MSC engineers feel the craft might have to break through the surface 1-2

How can we support life in this anti-life void?

So far, man has entered space for only a few brief orbits. The real problem is to support him in comfort and safety over long stretches of time while he performs useful missions.

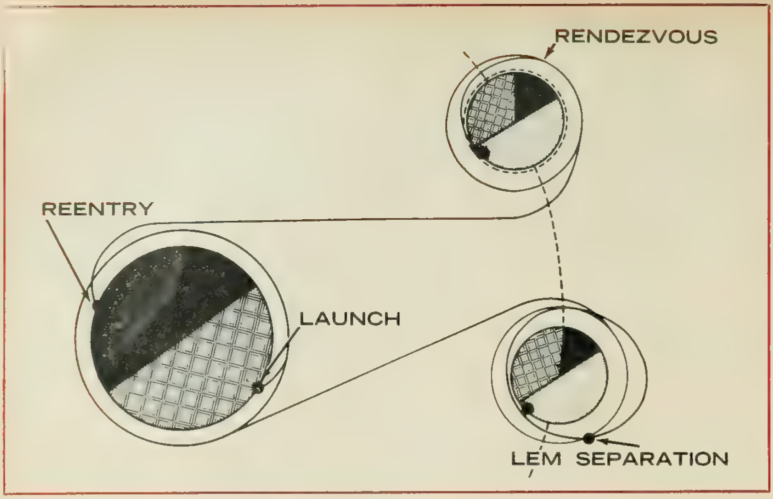
Nothing is friendly to flesh and blood in this savage vacuum. If man is to conquer it, we must build him a little world of his own—then shield it from the void.

We must know how to protect him from radiation and meteoroid impact...keep the partial pressures of his enclosed atmosphere finely balanced, prevent cabin temperatures from building past the point of tolerance...prevent disorientation and claustrophobia...keep tensions from building up between crew members.

A life-support system cannot be developed by bits and pieces. It requires a total systems approach—which no organization is yet able to provide. But the Research and Development Division of Lockheed Missiles & Space Company has been steadily building toward this goal, and now stands on the verge of total competency in life-support systems for space.

Lockheed

Lockheed Missiles & Space Company, Sunnyvale, California
A Group Division of Lockheed Aircraft Corporation



APOLLO-LEM FLIGHT PROFILE shows possible lunar parking orbit.

ft. to develop enough bearing pressure. "This is sort of like landing in a field of 2-ft. boulders," one engineer says.

Despite NASA's position, some recent reports by scientists credit the lunar surface layers with a bearing strength significantly higher than had previously been thought, claiming there is strength sufficient to support current landing craft design (M/R, June 10, p. 27).

In any case, testing the LEM gear for Moon use in an Earth environment is apt to be complicated. The answer probably will be found in either $^{1}/_{6}$-scale tests or with full-scale restrained drop tests.

The LEM 4,000-lb.-thrust ascent stage, being developed by Bell Aerosystems Co., will give LEM abort capabilities even as it is touching down on the surface. "Fire-in-the-hole" temperature and pressure build-up problems associated with firing the ascent stage at close range to the descent engine are not serious, engineers report, because of the rapid thrust build-up in the ascent stage and some additional venting being incorporated into the design. One engineer says that operating in a 10-14 mmHg environment makes for a pretty efficient pump to aid venting.

• **LEM ascent**—LEM will weigh about four tons for lunar take-off. The ascent engine will lift it clear of the landing gear and descent stage, which serve as a launch pad and remain on the lunar surface.

The vehicle will rise to 50,000 ft., where it will be injected into a "home-and-transfer" trajectory aimed at rendezvous with the parent craft in lunar orbit at a point not quite 180 degrees from the lunar launch site. Rendezvous is to take place at 100 mi.

This type of trajectory, NASA says, also gives a low ΔV requirement for the engine. In the event conditions are not right for rendezvous, or in case of premature lift-off or emergency, LEM can stay in a 50,000-ft. lunar parking orbit until conditions improve.

• **Communication needs**—An elaborate communications network is being planned to support the LEM astronauts both on their way to the Moon and on the Lunar surface.

The major component of this, operating in the 2,000-mc range, will be the S-band DSIF-type link between Earth and LEM. Probably two more stations will be added to this net, which now services Jet Propulsion Laboratory's lunar and planetary probe requirements. One will be in the central U.S. and another in southern Europe, specifically in support of *Apollo* (M/R, July 8, p. 33).

This link will be used for TV, telemetry, two-way voice, and will also allow two-way Doppler track of the spacecraft from the ground, which NASA reports will provide a range fix accurate to within 15 meters regardless of range. LEM will carry a side-mounted steerable S-band antenna.

The S-band link will also serve as a backup LEM-to-CM link, operating from LEM-to-Earth-to-CM, in the event of failure in the primary VHF LEM-CM link. Use of the S-band network for this will extend communications time between LEM and CM to about 70% of CM orbit time. This will be the normal route when CM is not in line-of-sight (LOS) of LEM.

The LEM-CM VHF link uses two separate frequencies and will handle two-way voice only. The same VHF link will exist between LEM and an astronaut on the surface. In addition to two-way voice, a small telemetry capability will be added for suit temperature and biomedical sensors. VHF links aboard LEM will use fixed antennas.

Communications between two astronauts on the surface outside LEM will use the same VHF link, but the signal will pass through the LEM, shifting frequencies as it does. Should this loop break down, there is still another single frequency backup VHF mode directly between astronauts.

The LEM astronauts will also be able to carry a small TV camera onto the lunar surface. The camera will be attached to a 64-ft.-long cable, long enough for a crewman to move outside the vehicle and take pictures that include LEM against the lunar background to give an idea of size and perspective.

• **Guidance systems**—Guidance requirements for LEM will be met with the same basic package Massachusetts Institute of Technology and its industrial support team (A.C. Spark Plug Div. of General Motors, Raytheon, and Kollsman) is developing under contract from MSC for the *Apollo* CM guidance. The IMU and associated digital computer are essentially the same for LEM as for the CM, though there are some hardware variations and a different computer program. Grumman engineers say the firm, in conjunction with MSC, has already incorporated LEM requirements in the MIT-*Apollo* effort.

In addition to the prime IMU, LEM will have a backup guidance system that will depend mainly on gyro and accelerometer elements of the LEM S&C system for guidance information in event of degradation of the IMU.

Supporting the basic IMU will be a considerable radar package now under RCA's jurisdiction. There is widespread industry interest in the amount of subcontracting RCA will do on this, but to date there is no clear indication. Observers close to the program expect that some of the radar package will be subcontracted by the firm's Burlington Mass., Div.

LEM will carry two basic radars—one for landing and one for rendezvous. Though design specs are not entirely firm, MISSILES AND ROCKETS has learned some of the "likely" details.

Both will operate at X-band and both will have individual antennas. The landing radar probably will be mounted on the bottom of the descent stage and have a forward-and-downward looking capability. This radar, which will make three component-velocity measurements plus altitude, is likely to be a coherent X-band device using three-beam Doppler with two-directional positions.

The rendezvous radar, mounted o the forward quarter of LEM (possibl on top of the ascent stage, looking forward and up) will be a gimballed coherent X-band unit operating in conjunction with a CM transponder. I will measure range, range rate, LO and LOS rate.

QUESTIONS SELECTED FROM RECENT EMPLOYMENT ADS WE HAVE READ

"Is your workground your playground?
Are you a duck hunter; one with purposeful imagination?
Are you on the high bridge?
Are you a robot or a martian geologist?
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Please complete this form and forward to: Mr. D. F. Waters, Professional Placement, Dept. 62MM, McDonnell Aircraft, St. Louis 66, Missouri. *This is not an application for employment.* Your qualifications will be reviewed by our placement staff and you will be advised of positions at McDonnell for which you qualify. You may then make application if you wish. All replies confidential.

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Primary Experience Area______ Number of Years______
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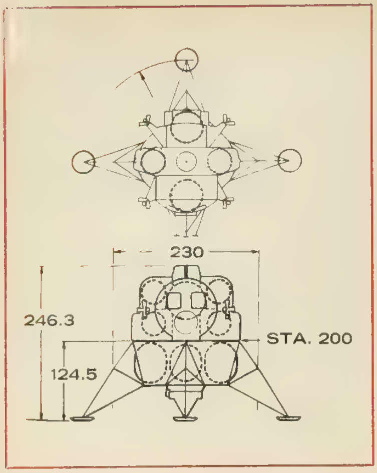
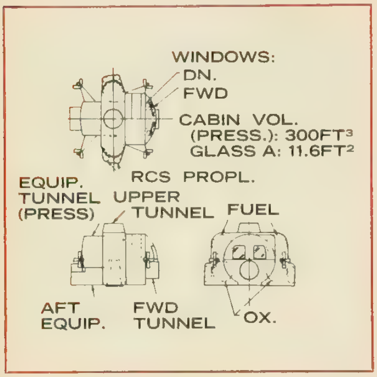
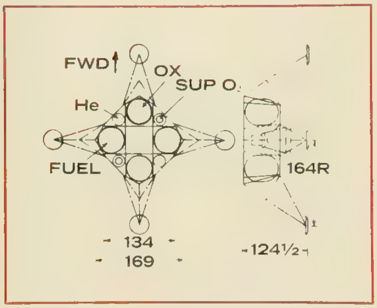


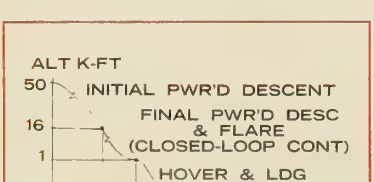
ENGINEERING DRAWING of LEM gives size. Dotted lines show fuel areas.



ASCENT STAGE ARRANGEMENT



DESCENT STAGE ARRANGEMENT



NOMINAL LANDING PROFILE

• **Power requirements**—The on-board LEM power will be supplied primarily by the hydrogen-oxygen fuel cell, in conjunction with some backup and "peaking" batteries for periods of extreme demand.

Current power profile looks like this: while in "idling operation" in trans-lunar phase, LEM will require about 300 watts; operating as a manned flying machine, levels will rise to about 1.5 kw, with peaks rising perhaps 50% above this, and even higher peaks of milli-second duration (RCS is a major user of on-board electrical power); lunar surface operations are expected to require about 1 kw.

These power demands are admittedly high in current design, but NASA hopes to knock the figures down "by as much as 50% as soon as 'power budgets' are introduced within a few weeks."

In recent weeks, NASA reports several other key studies of subsystem detail have been essentially completed, contributing to making the broad LEM concept firm.

It was decided, for example, that the LEM descent stage would have a gimbal-for-trim-only capability, and would not be used as an S&C element. This cuts down on RCS needs.

It was also decided to use baffles instead of bladders for ascent stage tankage—to avoid potential "fuel slosh" problems and difficulties with the roughly 40-in.-dia. tanks.

The basic form of tankage for the highly redundant RCS, layout of the electrical power system, stage tankage, fuel cell size, and lunar landing simulator inputs are also understood to be essentially completed.

• **Astronaut visibility**—One of the major areas still under study is crew visibility. Three interchangeable "faces" for LEM have been modeled in wood at Bethpage. All three have four windows, two facing forward and two downward. The downward-facing windows in two models are horizontal. The other model has a 45° "canted deck" window (which can be seen on the center mock-up in hangar bay photo), which is now said to be favored.

Overall visibility with this configuration is said to be best. It also allows the crew seat to remain in a single 16° forward position. At eye level, an astronaut can see 10 degrees up, 70 down, and, at the horizon, 21 degrees left and 23 degrees right with this arrangement.

The LEM crew station and inboard equipment bay will have the same shirt-sleeve environment as CM, but lack of space will keep it an open-face-plate affair. The cabin will have an oxygen atmosphere in the 3-5 psi range, with CO_2 removal via lithium-hydroxide canisters.

A spacesuit-type system will be used for waste control; the considerable input from *Gemini* experience is expected to influence final design. Hamilton Standard Div. of United Aircraft Corp. has responsibility for LEM life support.

One of the major design objectives in LEM was to make maximum use of equipment developed for the CM, a task made slightly easier since some of the CM hardware was designed for a landing mission before the shift to lunar orbit rendezvous. Most of LEM's "commonality" is found in the guidance, RCS, instrumentation system (PCM link and associated equipment), and the basic onboard communication gear.

In addition to common usage, there is also a critical trade-off continually going on concerning the measure of redundancy in LEM. "This is one of Grumman's key chores," NASA states.

Also continuing under study is the degree of in-flight repair. NASA says the concept of in-flight test and on-board spares wherever feasible is pretty firm, but some industry sources estimate it will be two years before the basic parts and man-maneuvers can be pinned down.

• **Eleven flight vehicles**—Grumman's funding of just under $390 million for LEM includes delivery of nine engineering development models, or LEM Test Articles (LTA's), and 11 flight versions. Before any of these are built, Grumman will also build five wood-and-metal mockups, and four test models, which are closer to engineering specs than are the mockups, but still relatively crude in comparison to the LTA's.

The first mockup (M-1) is built and has been in service for three months on visibility and crew-access studies. Portions of two others are also completed.

Work on two test models is already under way. One will be a full-scale antenna model using a copper screen around the wood frame. TM-4 will be used to check ascent/descent engine interfaces.

LTA planning is progressing, but no hardware is available yet. The first LTA (though not necessarily LTA-1) is expected to be completed at the end of '64. It will be used by Grumman as an integration model—to check electromagnetic interference and perform several other partial checks, including those of some propulsion systems.

LTA-2 will be used by Grumman and Marshall Space Flight Center for structural and landing gear evaluations. LTA's 3 and 4 will also be for Grumman structural and environmental tests. LTA-5 will go to White Sands, N.M., for propulsion checks. North American Aviation will run integration tests with LTA-6. MSC will get LTA-7, for environmental qualifications.

LTA's 8 and 9 will go to White

Sands to be used in conjunction with highly important piloted research programs, probably in 1966, which tie into both the flight and simulation program planned for LEM. In addition to the White Sands project, major LEM simulator inputs will come from the fixed-base simulator at Grumman, the Langley Field lunar landing facility, and the Flight Research Center vehicle at Edwards AFB.

The LTA's to be used in the White Sands test will be modified for piloted research in that most systems not having to do with the prime landing requirements will be off-loaded. Using only the descent stage for lift and descent, the LTA's will have roughly two minutes free-flight time, enabling some pilot experience and landing-system checkout.

• **Booster considerations**—Though details of the LEM flight vehicle schedule are closely guarded, it is known that the flight test program will include *Saturn IB* and *Saturn V* flights and probably two unmanned *Little Joe II* flights from White Sands.

Delivery of the first flight-model LEM is expected in 1965. A rough timetable for first suborbital unmanned launchings, using LEM plus a fairing to simulate the CM and SM, indicate the *Little Joe II* flights could go from White Sands late that same year.

Use of the 800,000-lb.-thrust version of *Little Joe II* would allow NASA to proceed with LEM development and flight tests without hampering *Saturn* development schedules, and would probably be less costly. The White Sands ests would all be suborbital, close-to-vertical firings, which would allow for LEM propulsion system tests including vacuum starts, staging checks, and shutdown and re-start of the ascent stage.

There are reported to be four LEM light versions, including spares, earmarked for unmanned shots.

First manned three-module *Apollo* orbital shot is slated for 1966 aboard he *Saturn 1B*. This mission is also expected to include some limited docking nd rendezvous maneuvers. NASA says t hopes to fully qualify LEM on board he *Saturn 1B*, bringing the *Saturn V* nto the program in 1967 for launchings vith LEM before the lunar attempt.

One reason for closely guarding the NASA flight schedule for LEM is that is still not certain how many vehicles hould be programmed for the mission's ifferent phases. About four of the ight vehicles are now said to be planed as lunar landers, but there is conderable study within LEM program nanagement involving use of some flight ehicles in lunar reconnaissance roles. NASA sources estimate it will be six to 2 months before the LEM vehicle programming is firm.

• **Gemini rendezvous inputs**—Decisions regrading the need and extent of actual rendezvous training in flight for *Apollo* crews, another factor in scheduling, will grow out of combined *Gemini* flight experience and simulator training.

MOCKUP OF LEM cabin with docking personnel-transfer tests in progress.

Though the complete lunar take-off and rendezvous maneuver will never be duplicated in training, many elements of long-range rendezvous can be brought into play in Earth orbit.

If a single booster were used, the spacecraft's on-board fuel requirements would be heavy. Some observers feel that this factor could lead to training using two boosters, as in *Gemini* or in the Russian "group" flights. "There is also an element of risk here," one top NASA engineer states, "that may do you no good. It is kind of like having a fighter pilot do a few parachute jumps in case he gets shot down in combat."

• **PERT taking shape**—To manage the extremely broad LEM program, NASA and Grumman will rely heavily on PERT. Grumman engineers say "first-cut" PERT charts on every subsystem are now completed, and should be applied in a few weeks.

Both NASA and Grumman officials feel that LEM has kept within contractual costs and neither foresees any overruns, barring any major shifts in a program that will not reach fruition for five years.

NASA officers here, some of whom have only recently left industry, have the feeling that "they have a better handle on this one than most other large programs." There has been some deliberation in naming subcontractors and outlining specs, but both NASA and Grumman officials feel this early drag will pay off later.

There is excellent rapport between MSC and Grumman. Though the basic LEM mission concept has not changed substantially since contract award, there is widespread praise for the manner in which Grumman has attacked the myriad of physical detail changes. ■

System Transfers Azimuth from Tower Top to Ground Monitor

Electro-optical device aligns missiles, astronomical telescopes, antennas; accurate to better than one-tenth minute of arc

by M. Monty Merlen

Barnes Engineering Co.

Stamford, Conn.

TO MEET THE critical aerospace need for accurately aligned elevated instruments, Barnes Engineering Company, Stamford, Conn., has developed an azimuth transfer system.

The device (now patented) will monitor accurately the true azimuth orientation of instruments on top of a nonrigid tower with almost the same precision as could be achieved on the ground. Transferred from the top of a 45-ft. tower, a reading will be accurate to 0.1 minute of arc; under ideal conditions, the reading will be within one second of arc.

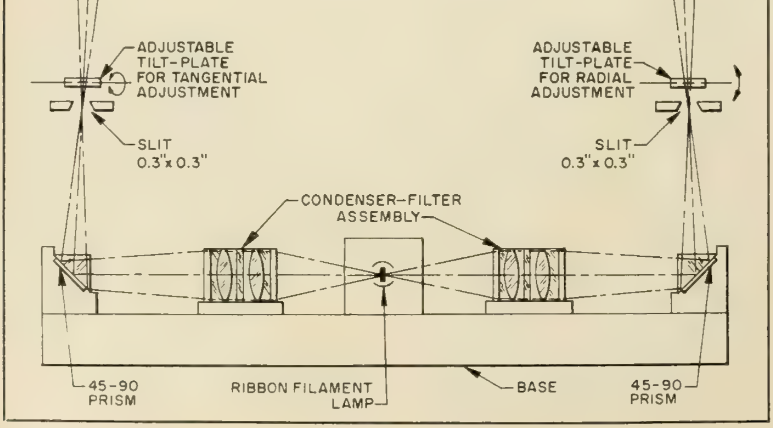
- **Essential elements**—The Barnes azimuth transfer system consists basically of ground- and tower-mounted components using an optical system for sensing rotational changes, and an electronic system to process, interpret, and relay the information.

Azimuth alignment of a rotating table or plate at or near ground level is transferred to another turntable element at the top of the tower by means of two light beams. Each beam, originating from opposite sides of a low-voltage ribbon-filament lamp on the lower element, passes through a condenser-filter assembly, and is then reflected upward by a 45-90-degree prism (refer to Figs. 1 and 2).

One light beam travels through a 0.3-in. slit, then through a tilt-plate designed to permit radial adjustments of the beam's image in the upper assembly. The other beam traverses similar optical components except that its tilt-plate permits tangential adjustments.

Suspended at the bottom of the upper assembly is a pair of matched objective lenses, each directed toward one of the light beams. The lenses focus the images of the lower light source on a reticle driven by a motor at 2 rps. This 10-in.-dia. photographically-prepared glass plate has 1,000 sectors; 500 transparent sectors alternate with 500 opaque sectors, and are subdivided into ten groups. Each group contains 25 narrow opaque sectors and 25 wide clear sectors, followed by 25 wide opaque and 25 narrow clear spaces. The total width of every pair of adjacent opaque and clear sectors is the same.

FIGURE 1—Optical schematic of lower assembly.


ADJUSTABLE TILT-PLATE FOR TANGENTIAL ADJUSTMENT
SLIT 0.3"x 0.3"
ADJUSTABLE TILT-PLATE FOR RADIAL ADJUSTMENT
SLIT 0.3"x 0.3"
CONDENSER-FILTER ASSEMBLY
45-90 PRISM
RIBBON FILAMENT LAMP
BASE
45-90 PRISM

- **Coarse alignment**—The design permits the reticle to chop the light into a 20-cycle frequency for coarse alignment, as well as into the basic 1,000-cycle generating pattern. Coarse alignment is required because the upper table has been designed for a range of ±5 degrees, whereas the fine detecting system has a range of ±30 min. The instrument automatically switches to the coarse mode of operation when the azimuth error exceeds 30 min.

When the azimuths of the upper and lower units are perfectly matched, the two beams are sharply imaged in a single spot in the reticle plane. The spot appears approximately in the center of a clear space on the reticle (Fig. 3, item A). A field lens above the reticle collects the light passing through and focuses it on a pair of radiation detectors, each receiving energy from one of the objective lenses. Light rays reach the detectors in phase and with equal intensity because the two beams are chopped at the same time and because the field lens collects all the light passing through the reticle.

If, however, either the upper or lower units are rotated relative to each other, the two beams are displaced in the reticle plane (Fig. 3, item B). Again the field lens provides the same illumination for each detector, but the phases of the interrupted light on the two detectors are slightly different due to the displacement of the images.

- **Electronic alignment**—At 4 in. from the center, the reticle spacing is 0.0125 in. A rotation of the lower unit of 10 sec. of arc produces a 0.000017-in. motion of each image at the reticle, or a relative motion of 0.000033 in. of the two images. Because each space orresponds to 180° (electrical) of the -kc signals, 10 sec. of rotation of ther unit generates a phase difference f 0.48 degree. Correspondingly, the 0-cycle modulation produces a coarse utput that has 1/50 of this sensitivity.

The combined 1-kc and 20-cycle rror and reference signals from each f the two detectors are then processed y the electronics system to produce the nal output signal, a d-c voltage with olarity depending upon direction of otation. When both units are aligned elative to each other, this voltage is ero. The final signal may be used to easure, to record, or, through servo oops, to rotate the table and assembly the top of the tower until it is in exact zimuth alignment with the element on e ground.

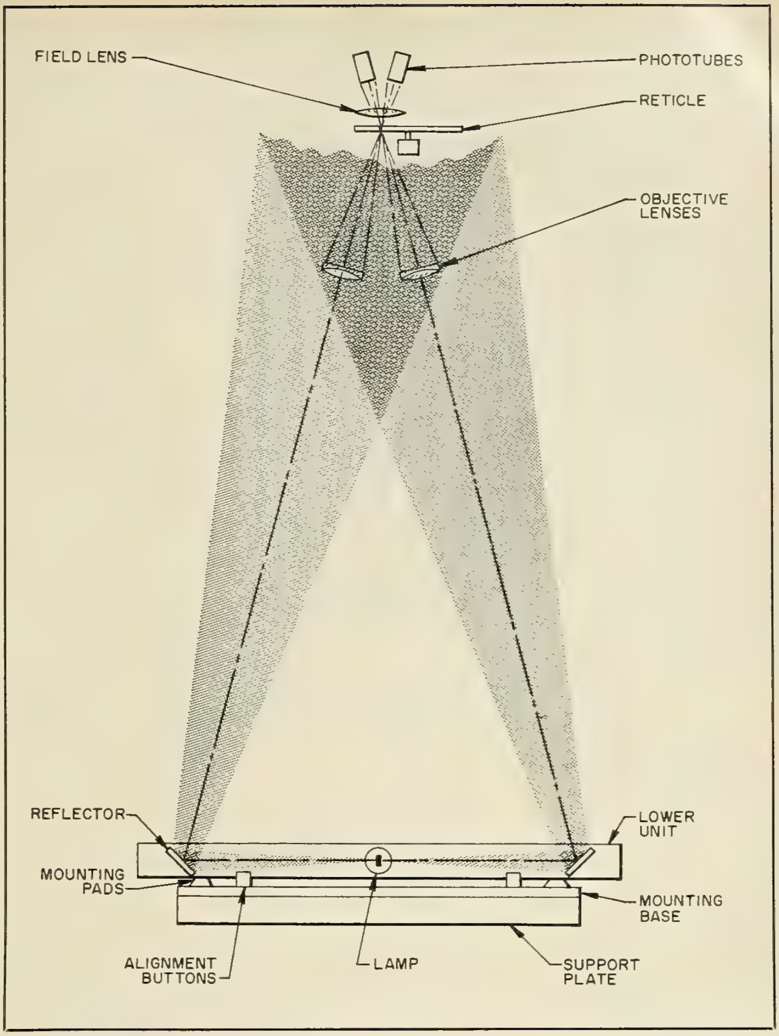
- **Special design features**—System ccuracy is independent of voltage fluc- ations, variations in light-source in- nsity, detector sensitivity, or atmos- eric attenuation of light. Further- ore, the system is insensitive to any otion of the upper and lower units, her than rotation in azimuth.

For example, if the tower bends, sulting in translational movement to e right, the images of the two beams erely move to the left nearer the riphery of the reticle. Thus, as the p of the tower sways, the images move unison, so that light beams are opped exactly in phase, and, because the field lens, both detectors receive ual illumination.

Verticle motion, on the other hand, roduces only a slight defocusing and ssibly a very small separation of ages along a line through the center the reticle. The two beams, however, l remain in phase.

Although the accuracy of the in- ument is not affected by translational vements of the table, even of very ge amplitude, tilt of the upper as- nbly does introduce errors. In order provide maximum precision, the per gimbal-mounted unit can be eled with use of a pendulum-arm de- e. In addition, the gimbal-mount per- s rapid, smooth rotation about the muth axis in response to error sig- s from the transfer system.

Any radiation with wavelength short ugh to obey optical laws can be d in the azimuth alignment system; isible infrared radiation, for ex- ple, is ideal for military operations. en permissible, the visible light is ferred because of its convenience, particularly to the high sensitivity visible-wavelength detectors. Opera- of the system is essentially identical all radiation frequencies, except that ical elements, radiation detectors and cle speed must be adapted to char- ristics of the radiation used. ■



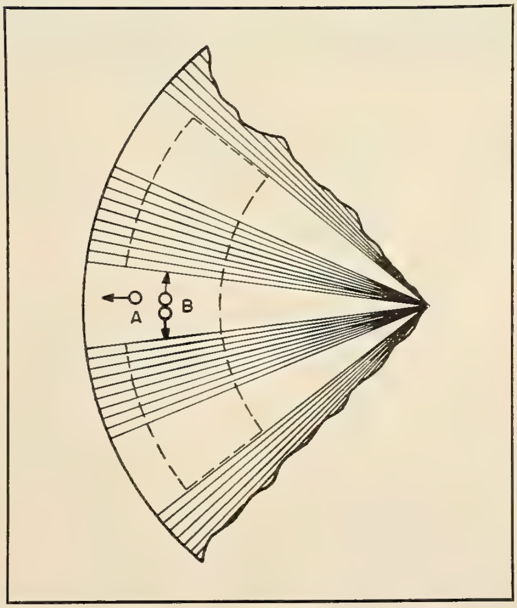
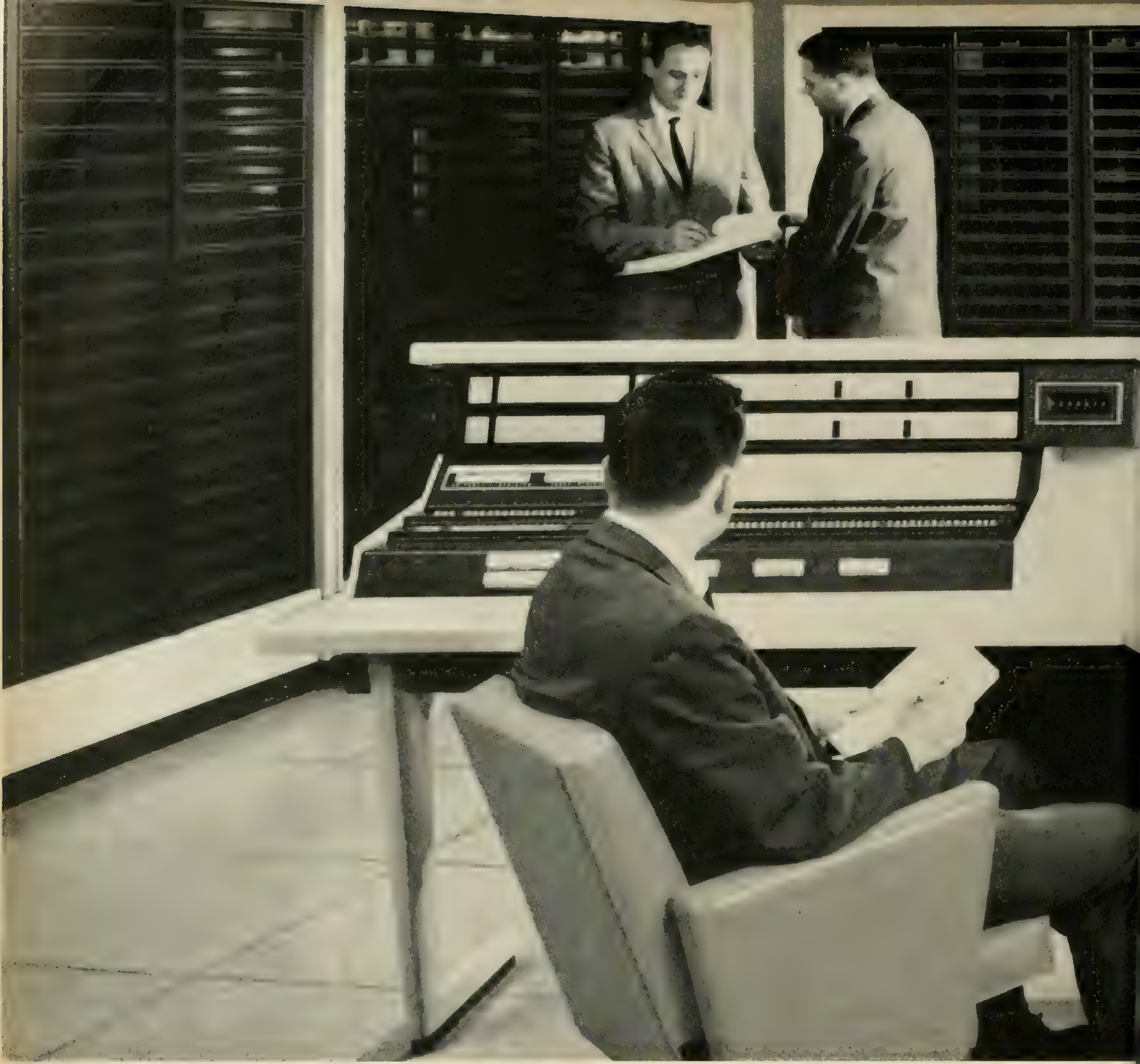


FIGURE 2 *(above)—Simplified schematic diagram of azimuth transfer system optics.* **FIGURE 3** *(right)—When azimuth of upper and lower units are matched, the two beams from light source are sharply imaged in a single spot (A) in reticle plane.*



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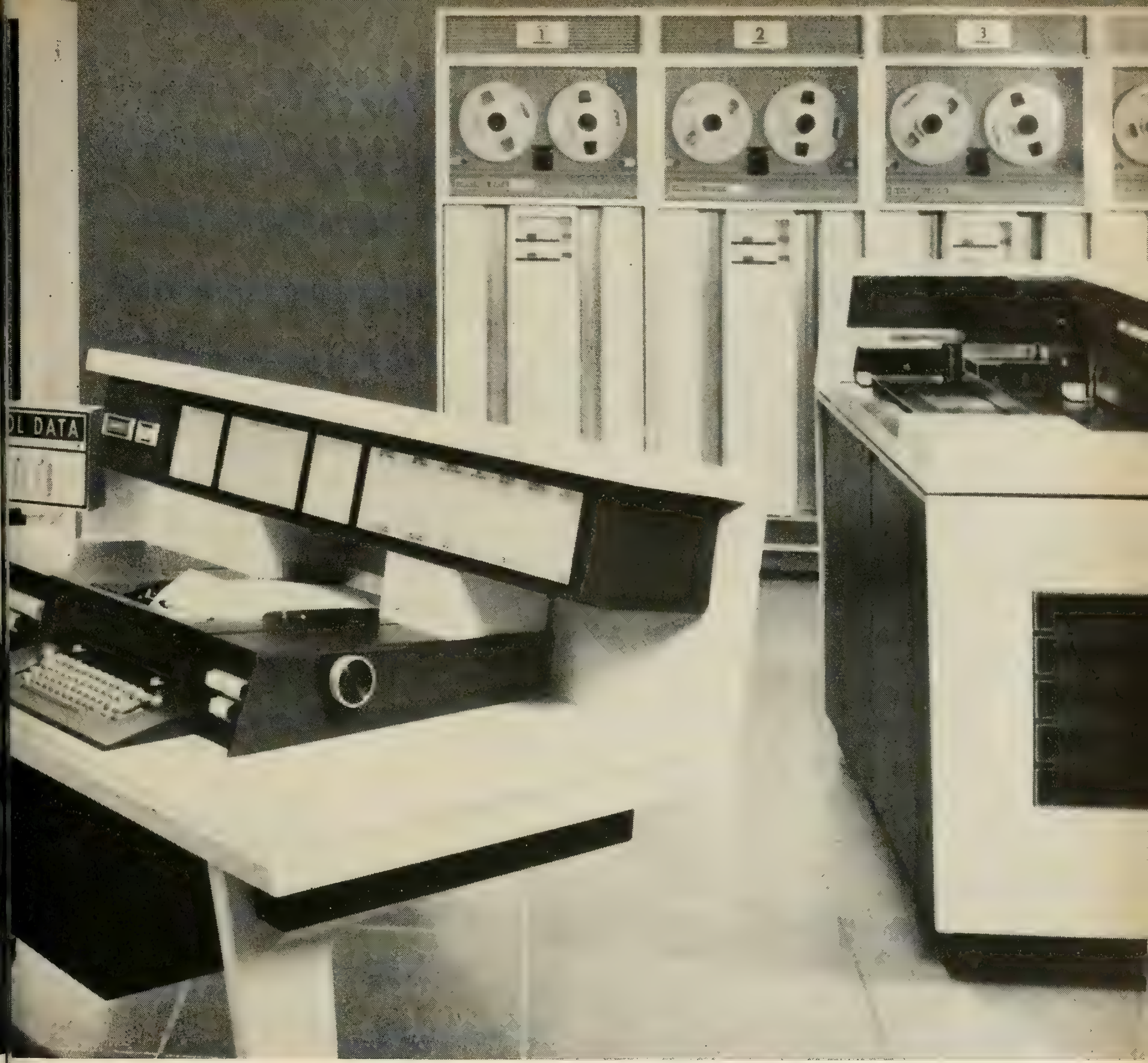

lantic Missile Range

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A. D. Little Study Probes Solid Propellant Ignition

Program, aired at AFOSR Meeting on Liquid Rocket Combustion Research, is funded by AF Flight Test Center

by John F. Judge

NANTUCKET, MASS.—A study aimed at developing methods to evaluate solid propellant igniter performance is under way at Arthur D. Little, Inc.'s Division 500.

Under the direction of Dr. E. Karl Bastress, scientists at ADL will probe for the interrelation among propellant grain dimensions, igniter characteristics and the response of the propellant to the igniter. The one-year program is funded by the Air Force Flight Test Center, Edwards Air Force Base.

Announcement of the contract was made at the recent 16th Annual Air Force Office of Scientific Research Contractor's Meeting on Liquid Rocket Combustion Research. Arthur D. Little hosted the meeting here.

The 16 papers delivered represented progress reports by various universities and industrial labs under contract to AFOSR to investigate and understand the complex problems associated with combustion instability.

- **Three types**—Combustion instability in liquid rockets has its basis in some form or forms of the many different possible vibrations. Some combustion vibrations cause severe damage while others are so minor they can be ignored.

All these vibrations are characterized by rapid fluctuations in chamber pressure, and irregular but cyclic flow phenomena of both the propellants and the generated gases.

George P. Sutton of North American Aviation's Rocketdyne Div. says in his latest edition of *Rocket Propulsion Elements* that these events are often accompanied by large increases in heat transfer to the chamber, injector, or nozzle walls.

Sutton goes on to describe the distinction among three types of vibrations.

—Chugging—characterized by chamber-pressure fluctuation at a relatively low frequency, usually below 50 cps. It is caused by an interaction between the combustion chamber pressure and the injector propellant flow. Feed-system dynamics affect this instability. This instability mode is usually eliminated by increasing the design injection pressure drop.

—Acoustical resonances—a second type of instability associated with the acoustical resonances of the combustion chamber and nozzle configuration. The frequency is a function of the chamber geometry, and is generally higher than 500 cps.

—Intermediate—the third type is intermediate in frequency, usually between 100 and 1000 cps. Its causes are not yet fully understood. It has been associated with resonances of various parts of the feed system and mounting structure, and vortex formation in the gas flowing around corners.

- **Princeton work described**—At the sessions, L. Crocco, I. Glassman and M. J. Webb of Princeton University described their work in pre-mixed gas rocket longitudinal combustion instability. They also disclosed a combustion instability model assuming a mass release from a short combustion zone that is instantaneously sensitive to thermodynamic conditions, even under high-frequency oscillatory conditions. No time-lag concept is involved.

A periodic solution for longitudinal oscillations with shock waves in a combustion chamber—long compared with the length of the combustion zone—was obtained. The authors concluded from this theory that there is a definite relation between the pressure wave profile and the form of mass release rate law assumed for the analysis.

T. Y. Toong of MIT covered his work in triggering mechanisms leading to the onset of acoustic oscillations in a combustor and the interactions of these with the triggering mechanisms.

Toong also observed that the energy transport between acoustic and flame oscillations can be decoupled under some flow conditions—indicating the possibility of finding an engineering solution to eliminate unstable combustion resulting from such couplings.

L. P. Combs of Rocketdyne described experiments with a transparent-walled, two-dimensional rocket combustion chamber using liquid oxygen and gaseous hydrogen. The quantitative data obtained has been used in formulating physically realistic mathematical models of rocket combustion for the particular injector types employed.

- **Rocketdyne models**—Data have been obtained during operation with three injector heads—coaxial jets, unlike triplets and oxidizer doublet/showerhead fuel—and a range of hydrogen temperatures. The experimental results have led to the formulation of two combustion models.

One considers the sprays to be formed in the presence of hot combustion products so that individual spray elements may be intimately and continuously surrounded by a combustion front. The other is formulated in terms of oxygen spray formation and hydrogen stream expansion in the absence of combustion, followed by their passage through a stationary flame front.

The second model was suggested by coaxial and triplet injector data, which strongly indicated the presence of a standing flame-front an appreciable distance from the injector.

- **'Quasi-steady' injection**—J. H. Rupe of Jet Propulsion Laboratory submitted simultaneously measurements of the pressure variation associated with several different locations on a chamber boundary during resonant combustion.

Rupe attempted to substantiate the postulate that the disturbance has the characteristics of a detonation wave, and, under appropriate conditions, can be sustained as such by a "quasi-steady" injection scheme.

Supplementary data on local heat-transfer rates, chamber erosion and the influence of baffles in attenuating the disturbance were presented.

Forcing a stably operating motor toward instability by inert gas injection into the recirculation zone formed the basic attack on the excitation of harmful oscillations within a combustion chamber discussed by Aubrey C. Tobey of Arthur D. Little, Inc.

Tobey's thesis is that in a stable system, the recirculating gases provide energy for continuous reaction of the mixture. Energy imbalance—as caused by small perturbations—creates ignition time-lag changes, which in turn create changes in overall reaction rates and fluid flow in the chamber, leading to instability. ■

Engineer Income Up 8% in Two Years

NSPE survey of members shows median salary is $11,460; aeronautical group, despite youth, trails only chemical, mining fields

THE MEDIAN INCOME of engineers in 1962 was $11,460—if members of the National Society of Professional Engineers are considered as being a true sample.

This income represents an increase of 8% over the median for the NSPE membership in 1960. The median number of years of experience for those in the 1962 survey was nearly 15 years.

The NSPE is an organization of individual professional engineers all of whom are registered under the engineering registration laws of the individual states. Organized in 1934, it contains 53 member state societies and more than 400 local chapters.

The recently released 1962 study is based on a 40% return of questionnaires from NSPE's 64,000 members. Thus the data are considered representative of the salary structure of the society's membership and probably of the engineering profession as a whole.

The study showed that earnings were high at all levels:

—90% earned at least $7,690.
—75% earned at least $9,220.
—50% earned at least $11,460.
—25% earned at least $14,950.
—10% earned at least $20,660.

These overall figures admittedly conceal some variations related to specialty, years of experience, and type and region of employment. But the study indicates that earnings increased at all levels between 1960 and 1962, and that the experienced groups fared particularly well.

Copies of the complete 1962 study—"Professional Engineers' Income and Salary Survey"—can be bought from the NSPE, 2029 K St., N.W., Washington 6, D.C., for $3.00; $1.50 to NSPE members.

• **Quicker experience**—it now takes less than 10 years of experience for most NSPE members to qualify for a $10,000-a-year income, according to the study. Between 10 and 20 years of experience, salary differences are sizable, but after 20 years of experience, the median tends to level off.

This survey pointed up a fact found in earlier ones: after about 15 years of experience, the earnings of the lowest paid group remain at an almost constant level, regardless of the number of subsequent years of experience. Thus, in 1962, the study showed that lower quartile earnings for middle-aged engineers were $10,280; for the most experienced, $10,950.

The lower decile never reached $10,000, even among the most experienced.

Chemical engineers were reported having the highest median earnings in 1962, followed by mining and metallurgical engineers. Aeronautical engineers came in third.

The high earnings of the aeronautical engineers were said to be especially noteworthy because "this is a young group, whose median incomes are high compared to those of other engineers at similar levels."

The NSPE study also revealed that engineers working for state or local governments earned at least $1,000 a year less than those engineers considered in the survey as a whole. Federal engineering employees "had a median income closely approximating that of the group of employees as a whole."

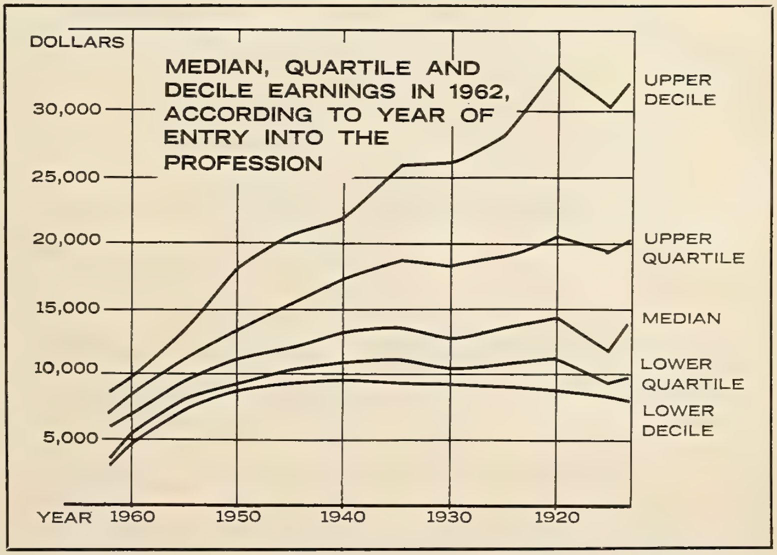
• **Professors profit**—One interesting aspect indicated that median earnings of engineers employed by educational institutions continued to show gains, "reflecting no doubt, in many cases, the availability of income from consulting and research assignments in addition to regular salaries."

The median income of those employed by educational institutions exceeded by about $1,000 that of the total group of employees surveyed.

About three-fourths of the respondents to the salary questionnaire classified their major branch of engineering work in one of the three largest branches —Civil, Electrical, and Mechanical.

In spite of a large range of professional branches to chose from—10 in all—a sizable group of respondents (6%) chose the "other" category. This was done, according to the surveyors, because the engineers either worked in specialized subfields such as nuclear engineering, or else their work and training crossed specialty lines.

Industry was the largest single employer of engineers in the 1962 survey. This group comprised 36% of the respondents. The second largest group comprised those working for government agencies at the Federal, state and local levels (25% of the total); and private consulting firms ranked third (19% of the total). ■



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Mergers and Acquisitions

Straza Industries, Inc., El Cajon, Calif., missile/space manufacturer, is expecting California Corporation Commission permission this week to conduct merger negotiations with Fluidgenics, National City, Calif. Fluidgenics makes missile valves and fluid regulators. . . . *Kearfott Semiconductor Corp. president, Stephen Cudlitz, has bought General Precision, Inc.'s interest in Kearfott. Under the agreement, General Precision will no longer manufacture transistors or diodes as components. Kearfott Semiconductor, Newton, Mass., has no connection with General Precision's Kearfott Div., Little Falls, N.J.* . . . Two International Telephone and Telegraph Corp. Defense Space Group units, International Electric Corp. and ITT Information Systems Div., have merged in keeping with ITT's emphasis on computer technology in communications systems. The new unit will be known as ITT Information and Data Systems Div. The merger will bring together responsibilities now shared by ISD and IEC. . . . *Koppers Co., Inc., Pittsburgh, has acquired the assets of Lamtex Industries, Inc., Farmingdale, N.Y., reinforced plastics manufacturer. Lamtex was a pioneer in the development of the filament winding process for manufacturing glass fiber reinforced plastics used on such missile/space programs as Minuteman, Nike-Zeus, Vortac and Discoverer.*

Industry Facilities

The Boeing Co. has agreed to lease 100,000 acres of public land from the State of Oregon. The area, in the north central part of the state, will be used as an R&D test site by the Seattle aerospace firm. Lease covers 77 years, but the state has the right to terminate it in 1970 if Boeing has not begun activities there by that time. Boeing also has the right to cancel at the end of any 10-year period beginning in 1970. Boeing is also planning to build a simulation center for space transportation research at Huntsville, Ala. The 20,000-sq-ft facility is expected to be in partial operation within 60 days. . . . *The Vitro Laboratories Div. of Vitro Corp. of America, West Orange, N.J., has set in operation a major pilot plant addition. The unit is to concentrate on producing semi-commercial quantities of various nuclear fuel materials, in addition to performing chemical process and development work. The move is the second step in Vitro's five-point expansion program for the West Orange R&D lab.* . . . Climax Molybdenum Co. of Michigan, subsidiary of American Metal Climax, Inc., has further expanded its refractory metal production facilities at Coldwater, Mich., to include the rolling of molybdenum-base alloys into finished sheet. The new $500,000 facility includes a rolling mill, sheet bar heating furnaces, straighteners, a heat-treating furnace and cleaning and inspection equipment, all positioned to provide a continuous operating sequence. . . . *Motorola, Inc.'s Semiconductor Products Div., Pheonix, Ariz., has expanded its facilities by 450,000 sq. ft. The $8.9-million reinforced concrete addition, now being occupied, will house integrated circuits assembly, silicon device production, environmental test areas, material operations, plant services and warehouse facilities.* . . . Rocket Research Corp., Seattle, has opened a new engineering facility. The new building, originally built for the Seattle World's Fair, provides a private office for each engineer. RR is working in advanced rocket technology for military and space applications. Principal products include small rockets for control and high energy rockets for primary propulsion of upper stages.

Representatives Named

Merquip Electronics, Inc., Chicago, has been named a distributor for Texas Instruments' Semiconductor-Components Div. Included in the SCR line will be 550 types of transistors, 230 rectifiers, 200 diodes, and 175 capacitors.

Potpourri

In the first aerospace industry application of Program Evaluation and Review Technology (PERT) to meet time and cost schedules, Martin Co. has termed its three-month PERT-Incentive program in development of the Air Force *Titan III* space booster a "complete success." *Titan III* was one of the first major defense projects to be placed with industry under an incentive contract. . . . *Northrop Corp.'s Norair Div., Hawthorne, Calif., has established a Technical Research Council composed of six leading scientists: Prof. S. M. Bogdonoff, head of the Gas Dynamics Lab., Aeronautical Engineering Dept., Princeton University; Dr. N. J. Grant, professor of metallurgy, Massachusetts Institute of Technology; Dr. N. J. Hoff, head of the Dept. of Aeronautical Engineering, Stanford University; Dr. F. E. Marble, professor of engineering, Guggenheim Jet Propulsion Center, California Institute of Technology; Prof. A. S. Niles, professor of Aeronautical Engineering (retired), Stanford University; Dr. A. T. Waterman, Jr., associate director of Systems Techniques Laboratory, Stanford University.* . . . North American Aviation, Inc., has been awarded the 1963 Greer Award, established in 1956 by Greer Hydraulics, Inc., to encourage solutions to product maintenance problems. The award is administered by the Maintenance Advisory Committee of the National Security Industrial Association.

AIR FORCE

$25,467,650—**Hughes Aircraft Co.**, Tucson, Ariz., for engineering and production of two new versions of *Falcon* air-to-air missiles.

$15,000,000—**Radio Corp. of America**, Camden, N.J., for operation, maintenance, and support of BMEWS equipment and facilities at Thule AFB, Clear, Alaska; Ent AFB; Offutt AFB; and Washington, D.C.

$7,700,000—**Carrier Corp.**, Syracuse, N.Y., for production and installation of environmental control system for *Minuteman* weapon system at Wing V.

$5,500,000—**Sperry Rand Corp.**, Great Neck, N.Y., for fabrication of ultra-high-frequency instruments.

$5,100,000—**General Electric Co.**, Syracuse, N.Y., for modification of tracking radar equipment.

$4,300,000—**Aerospace Corp.**, El Segundo, Calif., for space programs engineering services.

$3,300,000—**OMI Corp. of America**, Alexandria, Va., for photogrammetric plotter equipment.

$2,800,000—**David Clark Co.**, Worcester, Mass., for unspecified equipment.

$2,200,000—**Radio Engineering Laboratories, Inc.**, Long Island City, N.Y., for equipment for the DEW line system.

$2,200,000—**Douglas Aircraft Co.**, Long Beach, Calif., for continued work on the *Genie* missile program.

$1,900,000—**Thiokol Chemical Corp.**, Huntsville, Ala., for work on solid-fuel rocket motors.

$1,900,000—**North American Aviation, Inc.**, El Segundo, Calif., for solid-fuel rocket propellant.

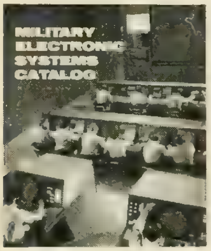
$1,700,000—**Radio Corp. of America**, Moorestown, N.J., for work on a radar system.

$1,600,000—**Sperry Rand Corp.**, St. Paul, Minn., for data-processing components.

$1,300,000—**General Precision, Inc., Link Div.**, Tarrytown, N.Y., for space-flight simulators and training devices.

$1,200,000—**Northrop Corp.**, Hawthorne, Calif., for work on an astro-inertial guidance system flight test program.

$1,100,000—**Electro Optical Systems, Inc.**, Pasadena, Calif., for work on a classified project.



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$499,748—**Utah State University**, Logan, for design, fabrication and installation aboard ICBM's of radiation-sensing instrumentation.

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$100,000—**Martin Co., Nuclear Div.**, Baltimore, for development of a direct energy conversion device which may be used with nuclear reactors in space.

General Dynamics Corp., Electronic Div., San Diego, Calif., for command and control information data display evaluation (undisclosed amount)

ARMY

$23,500,000—**Thompson Ramo Wooldridge, Inc.**, Canoga Park, Calif., for development of a command information system.

$6,421,530—**Raytheon Co.**, Lexington, Mass., for 36 high-power illuminator radars for the *Hawk* missile system.

$6,000,000—**Page Communications Engineers, Inc.**, Washington, D.C., for a scatter system for the Pacific area.

$5,400,000—**Collins Radio Co.**, Dallas, for a military integrated communications system.

$3,894,631—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, Utah, for work on *Sergeant* missile system equipment.

$3,700,000—**Philco Corp.**, Blue Belle, Pa., for further development of the Indonesian Communications System.

$3,600,000—**General Dynamics Corp., Pomona, Calif., Div.**, for continued research and development of the *Mauler* weapon system.

$2,294,963—**Martin Marietta Corp.**, Orlando, Fla., for ground support equipment and engineering tests and evaluation of the *Pershing* missile system.

$2,100,000—**Western Electric Co.**, New York City, for installation of modification kits for *Nike-Hercules* missiles.

$1,700,000—**Hughes Aircraft Co.**, Fullerton, Calif., for missile equipment.

$1,610,000—**Beech Aircraft Corp.**, Wichita, Kan., for production of Army Model No. 1025 *Cardinal* target missiles.

$1,500,000—**Radio Corp. of America**, New York City, for technical and engineering services at White Sands Missile Range, N.M.

$1,300,000—**Sperry Rand Corp., Sperry Utah Div.**, Salt Lake City, Utah, for replacement parts, hardware items, extension of research and development and spares for the *Sergeant* missile weapon system.

$1,030,841—**Raytheon Co.**, Lexington, Mass., for manufacture of *Hawk* missile system battery sets.

$1,000,000—**Burroughs Corp.**, Detroit, for electronics equipment and components.

$1,000,000—**R. D. Lowman, Inc.**, for White Sands Missile Range nuclear effects laboratory facility.

$737,237—**T.C.I. of Nevada, Inc.**, for construction of an Air Defense Command complex at Homestead AFB, Fla.

$158,986—**Giannini Controls Corp.**, Duarte, Calif., for vector miss distance indicator system for the White Sands Missile Range, N.M.

$107,450—**Textron, Inc., Fuel Engineering Div.**, for high-pressure storage vessels for *Apollo* PSD facilities at White Sands Missile Range, N.M

$75,725—**Southwest Welding and Mfg. Co.**, for fuel and oxidizer storage vessels, dump tanks for *Apollo* PSD facility at White Sands Missile Range, N.M.

$51,000—**Beech Aircraft Corp.**, Wichita, Kan., for target system spares.

$50,995—**Cosmodyne Corp.**, Hawthorne, Calif., for cryogenic storage vessels for the *Apollo* PSD facilities at the White Sands Missile Range, N.M

Sharps Construction Co., for ABRES Air Force re-entry facility at Vandenberg AFB, Calif. (undisclosed amount).

NAVY

$42,600,000—**Lockheed Missiles & Space Co.**, Sunnyvale, N.J., for production of tactical equipment for use on the *Polaris* missile syster (3 contracts).

$9,400,000—**Raytheon Co.**, Lexington, Mass., for production of *Sparrow II* missiles and work on radar equipment. Work to be performed at Bedford and Lexington, Mass., and Bristol, Tenn.

$6,300,000—**Radio Corp. of America**, Camden, N.J., for fabrication o radio relay sets.

$6,200,000—**Western Electric Co.**, New York City, for work on a telecommunications system.

$6,000,000—**Control Data Corp.**, Minneapolis, for a data-processing uni

$5,709,375—**Thiokol Chemical Corp.**, Denville, N.J., for *Bullpup* guide missile rocket engines.

$4,976,276—**Raytheon Co.,** Lexington, Mass., for production of *Sparrow III* guided missiles (supplemental contract).

$4,700,000—**Sperry Rand Corp.,** St. Paul, Minn., for production of computers.

$4,200,000—**Collins Radio Co.,** Cedar Rapids, Iowa, for radio equipment.

$4,400,000—**Westinghouse Electric Corp.,** for work on *Polaris* weapon system and torpedo components. Work to be performed at Sunnyvale, Calif. and Lansdowne, Md.

$3,200,000—**Raytheon Co.,** Lexington, Mass., for work on the *Sparrow III* guided missile.

$3,100,000—**General Dynamics Corp., Pomona, Calif., Div.,** for missile guidance components.

$2,500,000—**Stewart Warner Corp.,** Chicago, for transmitter-receivers.

$2,400,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Great Neck, N.Y., for weapons-directing equipment.

$2,100,000—**Hewlett Packard Co.,** Palo Alto, Calif., for oscilloscopes.

$2,000,000—**Westinghouse Electric Co.,** Baltimore, for radar sets.

$2,000,000—**Missiles Systems Corp., Entex Div.,** Cattletown, Tex., for target launchers.

$2,000,000—**Interstate Electronics Corp.,** Anaheim, Calif., for continued ballistic missiles development work.

$1,914,641—**Aerojet-General Corp.,** Sacramento, Calif., for rocket motors.

$1,904,103—**Hercules Powder Co.,** Wilmington, Del., for continued research and development on solid propellants.

$1,890,893—**Pennsylvania State University,** University Park, for research and development on naval weapons systems.

$1,800,000—**Bendix Corp.,** Baltimore, for work on missile testing facilities.

$1,798,514—**Raytheon Co.,** Lexington, Mass., for *Sparrow III* guided missiles (supplemental contract).

$1,700,000—**Northern Ordnance Inc.,** Minneapolis, for continued work on *Tartar* missiles.

$1,600,000—**Aerojet-General Corp.,** Azusa, Calif., for continued work on a torpedo development program.

$1,532,178—**Martin Marietta Corp.,** Orlando, Fla., for *Bullpup* guided missile launchers.

$1,459,306—**Raytheon Co.,** Lexington, Mass., for modification kits for the *Sparrow III* guided missile.

$1,200,000—**General Precision, Inc.,** Glendale, Calif., for production of navigational computers.

$1,130,000—**Westinghouse Electric Corp.,** Sunnyvale, Calif., for tools, test equipment and accessories for *Polaris* launcher systems.

1,090,583—**Bendix Corp., Mishawaka Div.,** Mishawaka, Ind., for *Talos* missile product engineering.

1,004,621—**Western Electric Co.,** New York City, for weapon direction equipment. Work to be performed in Winston-Salem, N.C.

290,629—**Northern Ordnance, Inc.,** Minneapolis, for launching systems associated with *Tartar, Talos, Terrier* and *Typhon* missile systems.

197,950—**DECO Electronics, Inc.,** Washington, D.C., for study of application of Moon relay techniques for a defense communications system, and to provide detailed system, subsystem and equipment design specs for the concept, using the Moon as a passive satellite.

Philco Corp., WSL Div., Palo Alto, Calif., for a design study of a control center for a *Transit* navigational satellite (undisclosed amount).

NASA

,500,000—**General Dynamics Corp., Astronautics Div.,** San Diego, for continued work on the *Atlas-Centaur* space booster system.

326,990—**Martin Marietta Corp.,** Baltimore, for five horizon sensors and two sensor power supplies for the *Saturn I* vehicle; design development and production of a new type of sensor for *Saturn V* instrumentation units.

550,000—**Princeton University's Daniel and Florence Guggenheim Laboratories for the Aerospace Propulsion Sciences,** Princeton, N.J., for a basic research laboratory to house the complicated and fundamental researches being carried out on the graduate level in the fields of liquid- and solid-propellant rockets, combustion materials, and nuclear and electric space propulsion.

52,800—**Standard Steel Corp.,** Los Angeles, for construction of a 35,000-gal. liquid hydrogen storage vessel.

12,188—**Space General Corp.,** El Monte, Calif., for *Aerobee* sounding rocket systems for 150A series.

02,000—**Kollsman Instrument Corp.,** Elmhurst, N.Y., for design, fabrication and assembly of point light sources for visual simulation system.

49,103—**Space Technology Laboratories, Inc.,** Redondo Beach, Calif., for a comparative design study of lunar supply operations modular stage concept.

00,000—**Radio Corp. of America, Astro-Electronics Div.,** Princeton, N.J., for design analysis of the wheel-shaped *Tiros* satellite.

50,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for preliminary design of the Mars mission re-entry module.

50,000—**North American Aviation, Inc.,** El Segundo, Calif., for the Mars mission module.

27,900—**Thompson Ramo Wooldridge, Inc.,** Cleveland, for study of ablative rocket liner deterioration in space simulation environment.

04,240—**North American Aviation, Inc.,** Los Angeles, for cryogenic insulation studies.

$83,228—**General Electric Co., Nuclear Div.,** Philadelphia, for a study of reactor heat sources using thermoelectric and dynamic power conversion systems.

$49,920—**Ipsen Industries, Inc.,** Rockford, Ill., for investigation of foamed metals for spacecraft.

$46,223—**Hughes Aircraft Co.,** Culver City, Calif., for development of protective cover materials for spacecraft antennas.

$40,091—**Martin Marietta Corp.,** Baltimore, for study of isotope heat sources for power conversion.

Applied Electronics Corp., Metuchen, N.J., for development and construction of the PCM telemetry unit for the ground checkout system of the *Apollo* spacecraft (undisclosed amount).

Emerson Electric Manufacturing Co., Electronics & Space Div., St. Louis, for *Saturn* guidance system studies (undisclosed amount).

Lockheed-California Co., Burbank, Calif., for a study to determine the most accurate method of predicting high in-flight temperatures for large rocket boosters (undisclosed amount).

INDUSTRY

$50,000,000—**Radio Corp. of America, Aerospace and Communications Control Div.,** Camden, N.J., from **Grumman Aircraft & Engineering Co.,** for work on the LEM communications system, radar, ground support, in-flight testing and parts of the stabilization and control system.

$1,500,000—**PneumoDynamics Corp.,** Cleveland, from **The Boeing Co.,** for design and manufacture of parts of the *Minuteman* weapon system.

$223,287—**Baldwin-Lima-Hamilton Corp.,** Waltham Mass., from the **Martin Co.,** for pressure transducers for the *Titan III* booster system.

$165,000—**Lear Siegler, Inc.,** El Segundo, Calif., from the **Sandia Corp.,** for development of high-strength cylinders made of maraging steel.

$130,000—**Texas Instruments, Inc.,** Dallas, from **The Boeing Co.,** for *Minuteman* ICBM electronic transducers.

Telecomputing Corp., Advanced Structures Div., Los Angeles, from the **McDonnell Aircraft Corp.,** for manufacture of a highly complicated close-tolerance phenolic core and fiberglas major structural bulkhead for the *Gemini* capsule (undisclosed amount).

General Motors Corp., Allison Div., Indianapolis, from **United Technology Center,** for provision of pressurization and injectant tanks for the thrust vector control system of the *Titan III-C* space launch vehicle (undisclosed amount).

Clary Corp., San Gabriel, Calif., from the **Philco Corp.'s Aeroneutronic Div.,** for a value engineering study (undisclosed amount).

WORLD'S FIRST
NUCLEAR POWER PLANT
IN SPACE

A Martin SNAP generator is still delivering full-rated power to a Navy satellite after two full years in orbit. For advanced nuclear capability, look to

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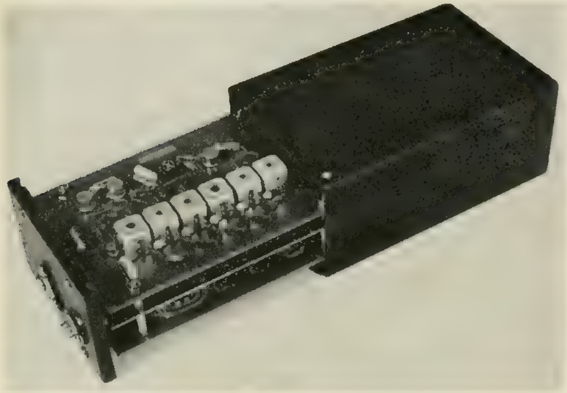
Circle No. 9 on Subscriber Service Card

New Product of the Week: Transistorized Receiver



Radiation Systems Inc. is marketing a completely silicon transistorized, crystal-controlled, single conversion receiver. The unit is available for operation at any frequency in the 50- to 250-mc band and standard units are designed to operate up to three decoders. Specifications include an input impedance of 50 ohms, sensitivity of —95 dbm/min., an image rejection of 55db, an audio response range from 500 cps to 10 kc ±3 db, and an AGC range from —95 dbm to —40 dbm. Configurations can be tailored to customer specifications and more complex decoders can be provided.

Circle No. 225 on Subscriber Service Card

10-in. Chart Recorder

In addition to 10-in. chart width, this unit offers a dual-sprocket chart drive, capillary pen system, a manual chart advance, 10-mv to 100-v full scale spans, and one or two of 16 available chart speeds.

Accuracy of the unit is 0.5%, sensitivity is 0.25% and response time is 1 second. The JY160 also offers floating input, controllable zero location, hum suppression circuitry, and chart paper tear-off bar.

The JY160 was designed for measurement and recording applications in industrial and scientific laboratories. It is particularly useful for electronic equipment stability tests and as a read-out accessory for gas chromatographs, recording microbalances, etc. Dimensions: 16 in. w x 9¼ in. d x 6½ in. h. Net wt.: 16 lbs.

Circle No. 226 on Subscriber Service Card

"Autobalance" Capacitance

The Wayne Kerr Corp., Philadelphia, has available the Model B-541 Capacitance Bridge with automatic balancing on all ranges and an accuracy of ±0.25%.

The bridge is a ture transformer-ratio-arm type, permitting 2- or 3-terminal measurements, and the associated circuitry is fully transistorized. The Model B-541 operates at 1,000 cps, and incorporates the patented Wayne-Kerr Autobalance circuit. This circuit employs the usual bridge ratio transformers, operating in conjunction with an operational feedback amplifier and a phase-sensitive detector. Three-digit readings are obtainable on each of the instruments' seven ranges, the first digit being determined by the setting of an 11-position decade switch, and the other two being provided by direct meter readings.

The decade switch functions as a coarse balance control, and the fine balance adjustment is automatically established by the feedback action. When the decade is at zero, the complete balance is established by the feedback alone. The meter registers the magnitude of the feedback signal, and is calibrated directly in microfarads or picofarads.

Circle No. 227 on Subscriber Service Card

Vacuum Pumping System

Kinney Vacuum Div., The New York Air Brake Co., has a mechanical booster which combines a 14,000-cfm lobe-type rotary booster pump, two 1,300-cfm lobe-type rotary booster second stage pumps (operating in parallel for a total displacement of 2,600 cfm), and a cam and piston type 500-cfm third stage pump.

The pumping system operates automatically from atmospheric pressure to a blank-off of 2 x 10^{-4} torr. When started, the third stage pump roughs the connected chamber to a pressure of 25 torr at which time the second stage units cut in. At 0.7 torr, the 14,000-cfm first stage starts. A rise above any cut-in pressure automatically stops the affected booster pump.

In conventional mechanical vacuum pumps, pumping speeds decrease as the pressure drops giving a relatively low volumetric efficiency in the low-pressure region. Mechanical booster pumps characteristically operate at high efficiency over a wide range of low pressures.

Circle No. 228 on Subscriber Service Card

PCM Decom System

Telemetrics, Inc., has just released data sheet 41, which provides a full description and specifications of Model 620 PCM Decommutation System.

The basic 620 System incorporates four major units: a bit synchronizer, a data synchronizer, a display panel and a power supply. Peripheral units, designed to augment basic system capabilities, may be included, or can be added later, to increase economic life.

Circle No. 229 on Subscriber Service Card

Telemetry Transmitter

Conic Corp. is marketing the Model CTM-205 5-watt solid-state telemetry transmitter. For use in all VHF telemetry applications, the units are hermetically sealed to withstand the environmental conditions encountered in missile and satellite telemetry systems. High reliability is achieved through use of adequately derated quality components. Semiconductors are silicon and are derated to an average of 40% of manufacturer's specified dissipation at 80°C. Computed MTBF (mean time between failure) reliability for unit is in excess of 20,000 hours The unit meets MIL-I-2-6600.

Circle No. 230 on Subscriber Service Card

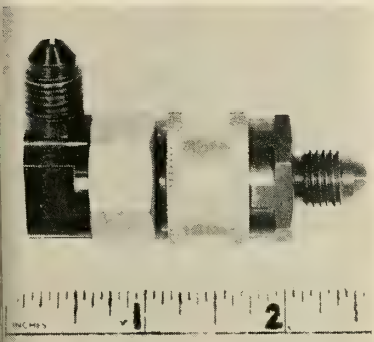
High-Power Heliax Cable

Andrew Corp. has designed and produced a flexible, air dielectric cable available for high power communication systems. Type H9-50 features inherent flexibility of Helian construction with its large size and power handling capability of 826 kw peak power. The convoluted inner and outer conductors of high conductivity copper permit bending around obstructions, simplifying installation and eliminating electrical discontinuities found in broken length installations. Produced in continuous lengths, Type H9 is available in lengths up to 1,000 feet. Splice free construction contributes to an exceptionally low VSWR up through 950 mc. Flanged-end fittings for Type H9 mate with 6⅛-in. EIA standard flanges and inner connectors.

Circle No. 231 on Subscriber Service Card

Fluid Coupling

The Power Equipment Division of Lear-Siegler, Inc., has available an extremely small and lightweight positive action, self-sealing coupling for a wide range of hydraulic and pneumatic applications. Originally developed for airborne use in a package cooling system for electronic equipment, the coupling has been modified for mass production and competitive pricing.



Designated as Series No. 25, the coupling can be supplied in straight-thru and angular (up to 90 degrees) styles. Each coupling features an automatic collar which provides for straight push-pull operation. A positive socket-to-nipple seal is effected even before the valves open. This results in a minimum of spillage and virtual elimination of air inclusion.

The series No. 25 coupling is available in a variety of materials including aluminum, brass, steel and various plastics. The anodized aluminum model weighs only 0.12 lb., and the connected length measures 1.85 in. from the center ine of the "L" fitting to end of the hex on the socket end. The maximum outside diameter of the straight-thru style coupling is 1.02 in.

Circle No. 232 on Subscriber Service Card

Protection Circuits

Harrison Laboratories announces the availability of a dual crowbar protector, consisting of two identical but independent overvoltage protection circuits that are housed as wins in a single package.

After adjustable voltage threshold is exceeded, the protected load device is shunted by a virtual short circuit within μ sec of time of overvoltage occurrence. Protective action lso opens relay contacts in series with a-c outlet and generates an output pulse for operating other crowbars in tandem. Crowbars can be "in-system" checked without shutting down the system. The dual unit is 3½ in. h x 11¼ in. d x 9 in. w.

Circle No. 233 on Subscriber Service Card

Regulated Power Supplies

Double regulated d-c power supplies for bench or system use are illustrated in a two-page, two-color catalog sheet available from Power Devices, Inc. Five models in the transistorized SP-2 series are described with complete electrical and physical specifications, theory of operation and outstanding features. Curves charting output current vs. ambient temperature and input voltage vs. output voltage are also included.

These economical supplies feature 0.01% regulation, 0.05% stability over 24 hours, and complete indestructibility, since they can operate indefinitely into a dead short. They are furnished with a 10,000-hour warranty. Powered from 105 to 125-volt input, at from 57 to 2000 cps, the five models offer outputs of 4-18v dc at 2, 4 and 8 amps, and 4-35v dc at 2 and 4 amps.

Circle No. 234 on Subscriber Service Card

Comparator Searches Tape

The Navcor Model 444 High-Low Comparator is now available as part of the complete line of 400 Series System Functions, which are available with both germanium and silicon components. The complete system function block incorporates all of the individual logic elements, such as AND gates, OR logic and inverting amplifiers, to detect equality between a known and an unknown binary number; and to give outputs which show whether the unknown number is higher or lower than the preset number. The module is built-up from MIL-Standard components on 5 x 6-in. epoxy glass card and is completely compatible with all other system functions in the NAVCOR 400 Series. Logic levels are —6.8 volts for "One" and 0 volts for "Zero." Outputs are clamped with a Zener supply located on each card, so that the only voltages required are —12 volts and +12 volts. Propagation time is a maximum of 1 microsecond/5-bits, which allows a full 10-bit word to be compared at a 300-kc rate.

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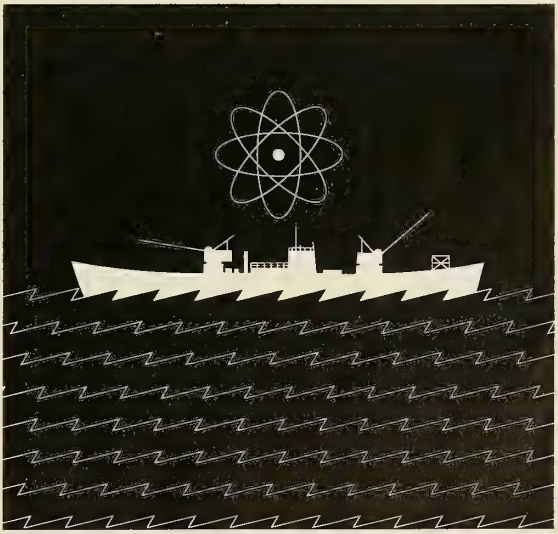
WORLD'S FIRST
SEA-GOING NUCLEAR
POWER STATION

Martin's MH-1A, now under construction for the U.S. Army Corps of Engineers, will supply 10,000 kilowatts of emergency power to STRAC or communities struck by disaster. For advanced nuclear capability, look to

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names in the news

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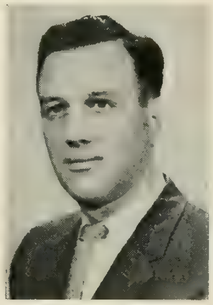
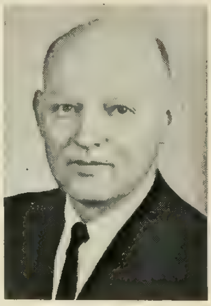

BADGER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BELL

Martin B. Curran: Promoted to manager, corporate and government advertising for the Raytheon Co., Lexington, Mass. **Adrian Van Dorpe** promoted to assistant manager, corporate and government advertising.

Roger E. Alcott: Appointed manager of ordnance marketing for the RADCOM-Emertron division of Litton Industries, Silver Spring, Md.

Edmund P. Plankis: Appointed headquarters sales representative for General Electric's Power Tube Dept., Schenectady, N.Y.

Dr. Algernon S. Badger: Named technical director of Test Equipment Corp., Houston.

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COLUMBUS DIVISION
North American Aviation

Robert D. Rosenthal: Named assistant general manager-technical for the Space Systems Div. of Fairchild Stratos Corp., Hagerstown, Md.

Edward O. Ansell: Named corporate patent counsel of Aerojet-General Corp., El Monte, Calif.

Dr. Edward A. Wolff: Appointed manager of the Space Engineering Laboratory of the Aero Geo Astro Corp., Alexandria, Va.

John W. Switack: Named manager of Thiokol Chemical Corp.'s Northwest District Office, Seattle.

Horace G. McDonell: Appointed general manager of the Vernistat Div. of the Perkin Elmer Corp., Norwalk, Conn.

Warren R. Barton: Named director of manufacturing of Bendix-Balzers Vacuum Inc. a new jointly owned enterprise of The Bendix Corporation and Balzers A.G., Liechtenstein.

George C. Callaway: Named manager of United Technology Center's Cape Canaveral operations where he will supervise the firm's activities in the *Titan III* program.

Raymond O. Bell: Appointed director of projects for Allis-Chalmers' Defense Products Div., Milwaukee.

Dr. Albert A. Gerlach: Named assistant director of the Research Laboratories Dept. of the Cook Technological Center Div., Morton Grove, Ill.

Fred K. Guest: Appointed director, program operations *Mobile Mid-Range Ballistic Missile* program of the San Bernardino, Calif., operations of Aerospace Corp.

J. Frank Price: Appointed president of General Precision, Inc.'s GPL Div., Pleasantville, N.Y.

C. E. White: Named manager-administration and material of the Hughes Aircraft Co.'s ground systems group, Fullerton, Calif.

Dr. James H. Gardner: Elected executive vice president and a director of National Research Corp., Cambridge, Mass.

Edward M. Dougherty: Appointed deputy managing director at ARO, Inc., Arnold Air Force Station, Tenn.

William G. Griffiths: Appointed manager of military and commercial microwave spare parts at Motorola's Chicago Military Electronics Center.

George O. Wilson: Named general manager of the Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc., Detroit.

E. M. Dagerman: Appointed application engineer in the Aerospace Div. of Vickers, Inc., division of Sperry Rand Corp., Torrance, Calif.

David M. George: Named manager of the development programs division for Thiokol Chemical Corp.'s Utah operations.

Eugene F. Hicks: Appointed to the eastern division sales engineering staff of Servonic Instruments, Inc., Willow Grove, Pa.

Donald W. Boensel: Elected senior vice president, long range planning at Correlated Data Systems Corp., Glendale, Calif. **Jennings R. David** elected vice president and general manager.

Saul Kurlat: Appointed vice president-planning at Technical Operations, Inc., Burlington, Mass. **Dr. Donald W. Meals** appointed vice president-system sciences.

S. J. Nuzzo: Appointed head of the customer liaison department for the Electronics Div. of Hazeltine Corp., Little Neck N.Y.

Bernard J. Sledzik: Named field sale manager at United Aircraft Corp.'s Norder Div., Norwalk, Conn. **Lawrence A. Gerbe** named video systems marketing manager.

James D. Esary, Jr.: Named director o labor relations for the Boeing Co., Seattle

Dr. Harry H. Beacham: Appointec manager of FMC Corp.'s Applications anc Technical Service Laboratory, Baltimore.

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JULY

American Astronomical Society Meeting, University of Alaska, College, Alaska, July 21-24.

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

Toxicity in the Closed Ecological System, sponsored by U.S. Navy's Special Projects Office and Lockheed Missiles and Space Co., Lockheed Research Laboratories, Palo Alto, Calif., July 29-31.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

Sixth Annual Institute of Missile Technology, sponsored by the University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News*, University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference, sponsored by NBS and Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

1963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug. 23.

AIAA Simulation for Aerospace Flight Conference, Deshler-Hilton Hotel, Columbus, Ohio, Aug. 26-28.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

AIAA Conference on Physics of Entry into Planetary Atmosphere, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference & Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

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A Message to Company Presidents

FIRMS IN THE missile/space industry always have shown a fierce and rightful independence in this highly competitive business. But events of recent weeks suggest that the time may have come for leading companies to override their competitive instincts in a mutual effort for the benefit of both the nation and the industry.

There is a developing groundswell of public lethargy, and even antipathy, to the U.S. space program. This may be somewhat natural in view of the heavy financial demands of the program, but it can be devastating to the best interests of this nation.

For an example, one need only examine the views of one of the nation's leading scientists, Dr. Philip Abelson, director, Geophysical Laboratory, Carnegie Institution, as aired during hearings last month before the Senate Space Committee.

Dr. Abelson told the committee he had conducted an informal poll among scientists not connected by self-interest to programs of the National Aeronautics and Space Administration. The vote, he said, was 110 to three against the present manned lunar program.

"Manned space exploration has limited scientific value and has been accorded an importance which is quite unrealistic," Dr. Abelson declared.

"When Congress votes to support an area such as space and to give it the funds necessary to hire personnel, it simultaneously votes to take competent people away from other and often important activities," he testified. "I believe that diversion of talent to the space program is having and will have direct and indirect damaging effects on almost every area of science, technology and medicine."

While other scientists of equal ability and repute contested Dr. Abelson's views before the committee, he nevertheless represents a significant and influential group in the scientific community and, indeed, among the public in general.

There is little doubt that these views are having an effect on public opinion. A recent poll among U.S. teenagers disclosed that 29 percent of them felt that the billions of dollars going into the lunar landing program could better be spent elsewhere.

"We should use that dough for curing cancer and heart disease and to improve the standard of living of millions of people throughout the world," declared one in California.

"I should think that we could be doing research in more useful areas and deriving far more benefits," said another in Massachusetts.

If more than a fourth of the adventuresome teenage group feels this way, then the message somehow has failed to get across.

What is the problem? We believe that the companies in this industry, engaged in the understandable day-to-day preoccupation with business affairs in a highly competitive field, have neglected an important part of their duty to the industry and to the nation. We in the industry have left almost entirely to NASA and to interested members of Congress the task of explaining the importance and the goals of the national space program to the public.

True, there have been scattered efforts by individual firms to explain the space effort in their local communities, but this quite apparently has not been sufficient. A national effort by the industry has been lacking.

Judged quite frankly from a viewpoint of industry self-interest, the failure to explain the importance of space to the public can have a disastrous long-term effect. Despite a lot of arguments to the contrary, this still is a democracy and the views of the voting public have a considerable impact on Congress—which must provide the funds for the space program.

We have a considerable faith in the American people. When the facts are before them, they have an impressive record of coming up with the right judgments. Those who insist that "the people" have no influence, that the decisions are made solely in Congress, are selling our system short.

WHAT THEN MUST be done? We think that what Madison Avenue likes to call "a real grass roots" consumer campaign, financed in a cooperative effort by leading industry firms, is urgently needed. A serious and continuing effort to educate the American people on the benefits and objectives of the national space program—and to keep them well-informed—would be immeasurably beneficial to the nation and at the same time be excellent long-term insurance for the future of this industry.

To those of us intimate with its details, it may seem strange that the public would have to be educated in this field. But we also have to realize that it is less than six years ago that *Sputnik I* was launched and the world was catapulted into the Space Age. The public cannot be expected to have fully grasped the implications and importance of this field in so short a time. To many, it is still a short step from science fiction and who needs it?

How could such a campaign be organized? A national organization such as Aerospace Industries Assn. might, of course, be in a position to undertake such a project. But AIA would be somewhat hampered by the very size of its organization. We would like to see a small group of the top executives of the largest companies in this industry assembled to consider such an effort.

We would like to see this group seek an imaginative approach from those more oriented to consumer selling than this industry is. Let General Electric seek advice from its man in charge of selling toasters; let General Motors, Ford and Chrysler turn to their automotive marketing directors and ask, "How do you sell the public?"

There are many approaches, in addition to just consumer advertising, which would have to be considered. And with a program outlined, it would have to be financed.

But we are idealistic enough to think the major companies in this industry would be willing to do it for the benefit of their nation. What about it, Mr. missile/space president?

William J. Coughlin

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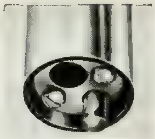

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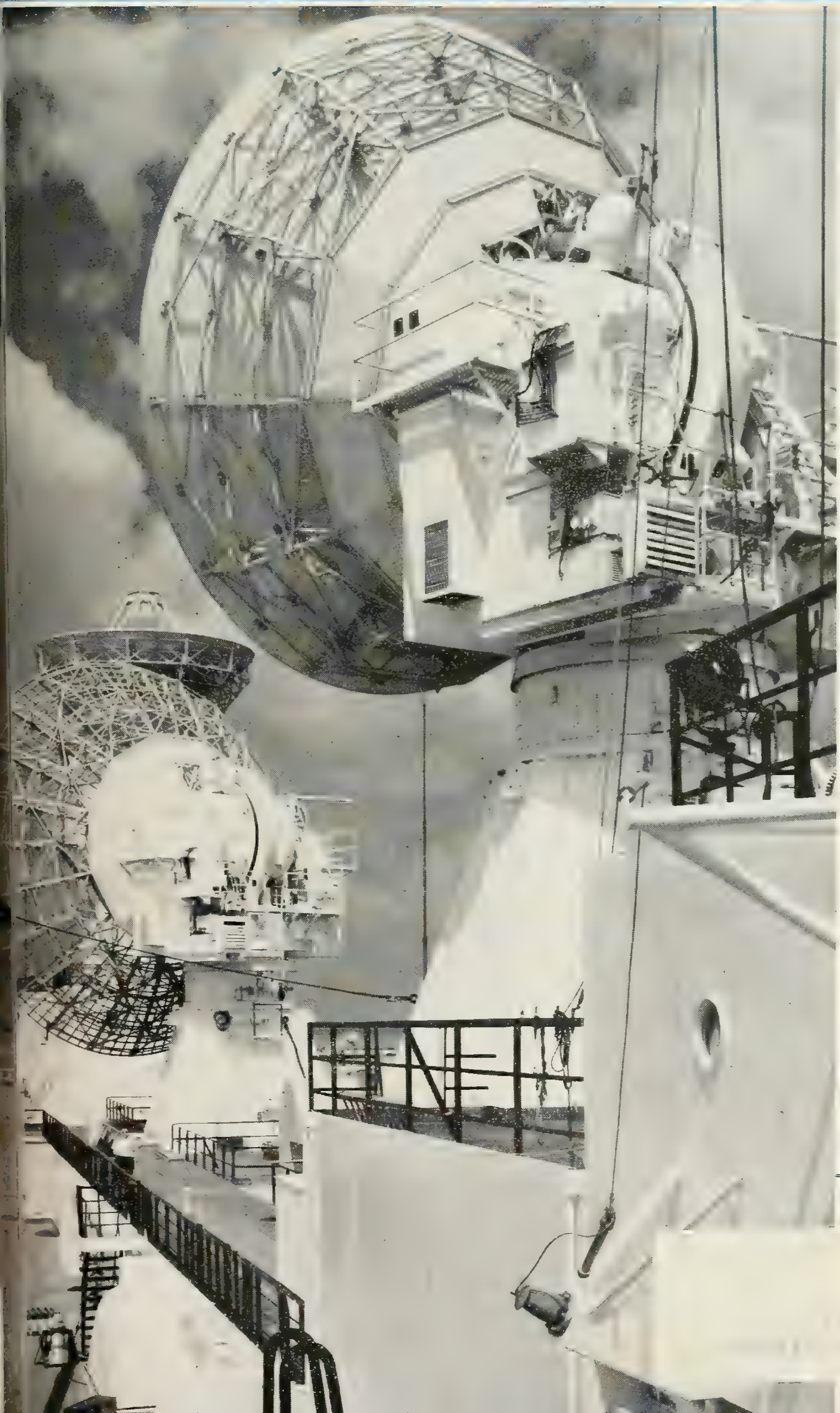

Special Report— How to Do Business In Europe

- **Flux in Space Management**
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Antennas on ARIS Ship

Turning theory into hardware

Technological breakthroughs are almost an everyday occurrence in electronics. Everywhere we see many new scientific discoveries being turned to the service of man.

Hughes is one of those companies whose obligation is not only to form these theories, but also to visualize how they might be applied. And then to make that application — both in man's defense and in the betterment of his life.

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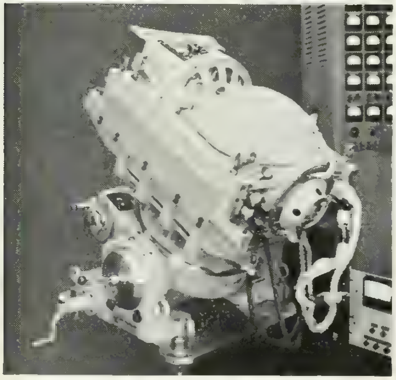
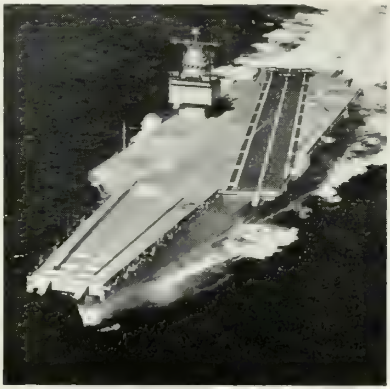


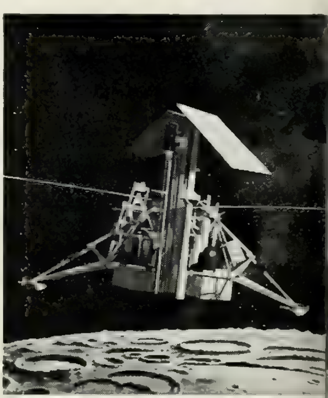
Polaris missile brain

Through the application of its advanced manufacturing technology, Hughes is now a prime contractor in inertial guidance systems (illustrated above) for the U.S. Navy's Polaris missile. It is one of the world's mightiest, most reliable forces for freedom.



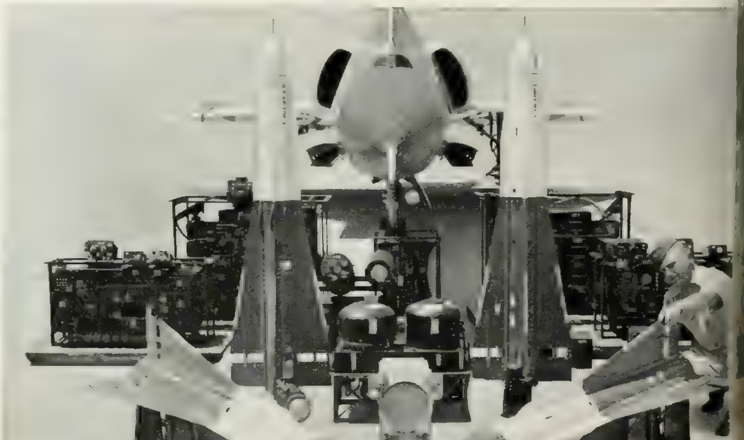
Enterprise "Eyes"

Like giant billboards, Hughes detection and 3-D tracking radar on the 4 sides of the Enterprise tower scan hundreds of miles of air space to track great numbers of supersonic targets. Utilizing Hughes *frequency scanning* invention, these antennas position beams electronically — eliminate mechanical movement and complexity — are "hardened" against damage.



Surveyor

Hughes Surveyor is designed to give information on conditions in flight and land" instruments which will report information about the moon back to ea first of seven Surveyors being built by for NASA under Jet Propulsion Labora technical direction is scheduled for launch early in 1964.



Modern Falconry

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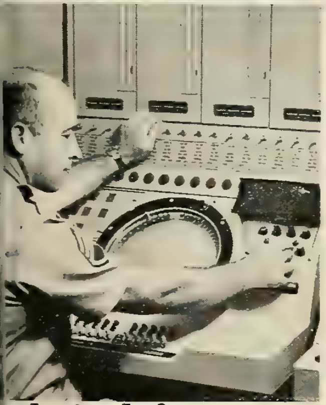

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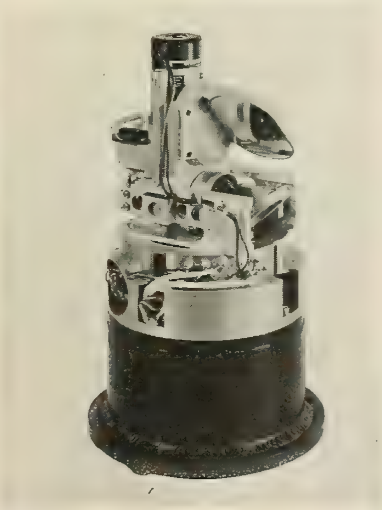
Ion engines for deep-space probes

Hughes research into the theory of electrical propulsion has led to development of ion engines which are called the "ultimate" source of power for deep space trips. Built for NASA, Hughes cesium-powered ion engines have been "test-flown" in space-simulating vacuum chambers—and are scheduled for actual test in space within the year.



Star Tracker

One of many Hughes infrared activities, this stellar tracker will help navigate the Surveyor lunar landing vehicle on its trip to the moon. This tracker will identify the star Canopus simply by the amount of light energy it generates permitting the star to be used as a navigational "fix."

Laser Ranger

Accurately measuring distances to within 15 feet in seven miles, Hughes Colidar* Rangefinder enables artillery spotters, tanks and aircraft to instantly pinpoint targets. The device "bounces" a coherent light beam off the target, computes the distance and reads out the range. Other uses include calculating closing rates between spacecraft and high resolution mapping.

*Trademark Hughes Aircraft Company

An elegant, but tiny refrigerator, utilizing the Nernst-Ettingshausen effect, has been demonstrated in the Solid State Physics Laboratories at Lockheed Missiles & Space Company. This type of cooling is applicable below 200° Kelvin, where thermoelectric cooling is no longer efficient. It shows particular promise for space application because of the reliability inherent in its all-solid state construction.

In the Nernst-Ettingshausen effect, heat is pumped as a result of an electrical current flowing in a magnetic field. The heart of the present device is a bismuth antimony single crystal. Other crystal systems are also being investigated.

This thermomagnetic cooling device is one of the results of the Lockheed research program in transport phenomena in solids.

Another investigation concerns the quantum theory of the electronic structure of crystals. An ingenious computer program has been devised for determining the essential features of the energy band structure of a wide variety of crystals. Results for a given case can be obtained in an hour or less. Conclusions drawn from the theoretical solution elucidate many of the electronic properties of crystals, and have widespread significance.

Lockheed scientists and engineers are also studying: Electron spin echo phenomena; the interaction of electrons with microwave phonons; coupled traveling waves in crystals; semiconductor lasers; antiserromagnetic resonance; various theoretical and experimental aspects of superconductivity.

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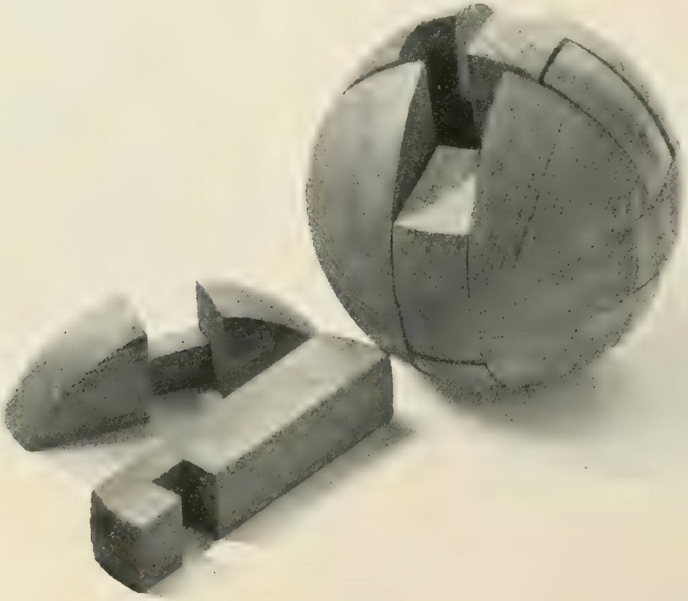

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 13, Number 4 July 22, 1963

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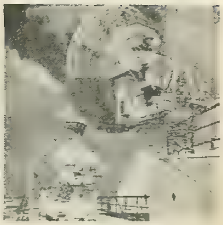

View from stern of USAFS Vandenberg, second Air Force Advanced Range Instrumentation Ship, shows heavy antennas. The Vandenberg, which was scheduled for dedication July 18, will see tracking duty with the H. H. Arnold in the Indian Ocean. See p. 34.

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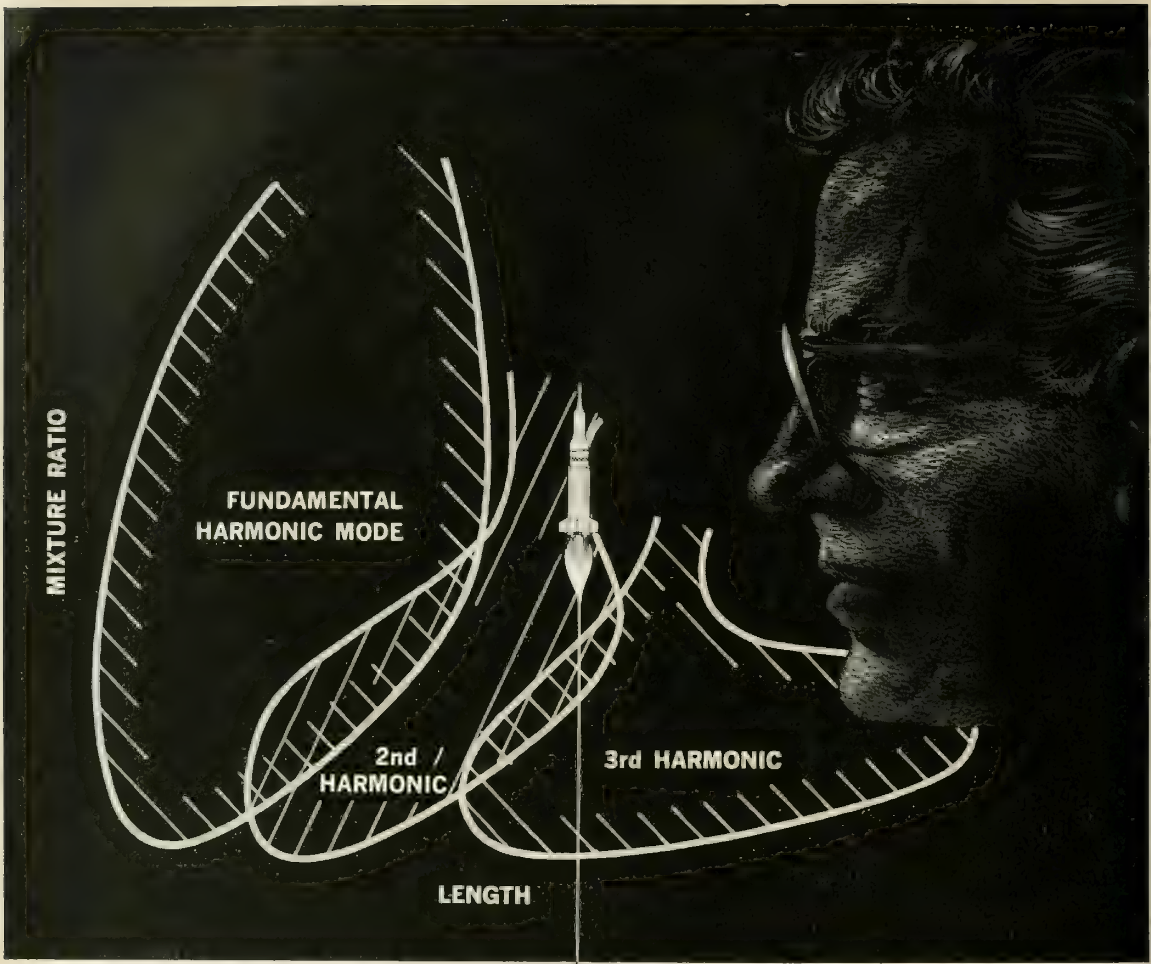

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letters

Selling Space

To the Editor:

Congratulations on your timely editorial ("A Message to Company Presidents," M/R, July 15, p. 46) on the urgent need for a consumer campaign to win greater understanding and support by the American people for our national space program

Opinions about this program, expressed in a recent poll of adult men and women conducted by this agency, confirm the findings of the poll of teenagers mentioned in your editorial. In our opinion poll, 34% said we are spending too much money on the national space program. While 61% favored President Kennedy's Moon program, 31% said it should be slowed down. It is the opinion of our research people that of those who expressed satisfaction with current programs about half realistically could be considered to have "no opinion" or to be "on the fence."

I look forward to the outcome of your suggestion that the industry seek the aid of experts in marketing consumer products to help win the American people to the cause of space. As many industries have learned, many good causes and ideas have attracted greater public understanding and support through aggressive public information programs built around modern marketing know-how as practiced in selling consumer products. The areas of health, safety, transportation and education are good examples.

Tom Johnston
Vice President
Hicks & Greist, Inc.,
Advertising and Public Relations
New York City

Gremlins

To the Editor:

Now that our esteemed president, Dr. Ruben F. Mettler, has been demoted by MISSILES AND ROCKETS to executive vice president of Space Technology Laboratories (M/R, June 24, p. 9), perhaps he *would* be interested in the newly vacated NASA position of director of the Office of Manned Space Flight (mentioned in the same item).

C. N. Tsu
Member, Technical Staff
Space Technology Laboratories
Redondo Beach, Calif.

Our apologies to Dr. Mettler. We knew better.—Ed.

Von Karman Admirer

To the Editor:

I've been wanting to let you know how much I appreciated your truly fine editorial on Dr. von Karman in the May 13 issue.

Fred Singer
Weather Bureau
Washington, D.C.

UAC's Cyborg Study

To the Editor:

In your May 13 issue, I have noticed with great interest an article entitled "UAC Cyborg Study in Second Phase" (p. 41). I have noticed particularly in the second column that the United Aircraft group has been working on an experimental heart device to study the engineering aspects of flow turbulence and pressure characteristics of the heart pump and valve assembly. On the same page, the picture indicates that the artificial heart being used is too large for mobility.

Incidentally, quite recently in Japan one of the micro-motor manufacturers has developed a very reliable artificial heart which was experimented successfully on a living dog at the surgical clinic of Tokyo University.

Y. Tamiya
Assistant Manager
C. Itoh & Co. (America) Inc.
Chicago

The experimental heart device shown in the UAC photograph is an engineering analog of the heart and valves which UAC researchers will use to measure effects of stress on the activities of the human heart. —Ed.

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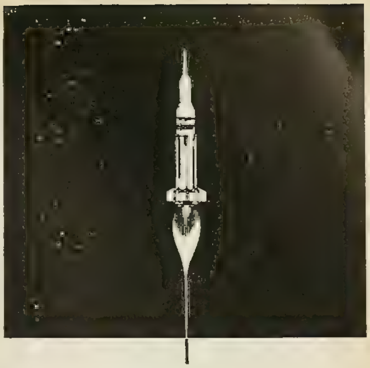

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Aerothermo Mechanics (aerodynamic testing, analysis, stability and air loads; heat-transfer studies; thermodynamics of power systems and cryogenic storage; aerothermo research in theoretical gas dynamics, radiation physics, and computer programs.) Flight Mechanics (trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics and celestial mechanics.)

FUTURE SYSTEMS ANALYSIS
Mission analysis and planning operations research, advanced program planning, human factors.

ELECTRICAL and ELECTRONICS
Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES
Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

MANUFACTURING
Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

PROGRAMMERS
Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

QUALITY CONTROL
Supervise and maintain reference of standards in mechanical systems, electrical systems, quality assurance and systems automation; evaluate instructions and test procedures and develop techniques for adapting digital computers for automatic checkout systems.

RELIABILITY
Develop analysis methods and techniques; analysis in electrical, mechanical, electro-mechanical, structural, propulsion, systems and other areas; evaluate program; recommend engineering changes.

STRUCTURAL, PROPULSION and RELATED ENGINEERING
Stress, structural dynamics, propulsion, cryogenics, aerodynamic loads, hydraulics, weights, materials, documentation, drafting, electro-mechanical component installation design, and development of computer solutions for all phases of structural and mechanical analyses.

SYSTEMS INTEGRATION
Mission planning, functional integration, design criteria and mission evaluation of space vehicle systems and subsystems and digital automatic checkout equipment.

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THE NEW CRAFTSMEN Fingers are not made for sensing millionths of an inch. Nor can the eye discern such tolerances. Yet every day the production workers of today's aerospace industry turn out instruments and components which are accurate to the millionth degree.

Though they deal in variances as fine as a wave length of light, these men are neither scientists nor engineers. In most cases they were previously untrained for the job. But the parts they produce are so uniform that a precision instrument like the gyro can be mass-assembled from elements chosen at random.

Behind this effort, shaping the techniques that make it possible, are the industry's production experts. Clear-sighted men who know that reliability is not only designed into a product, but also must be *built* in.

Together, these experts and workers have turned production-line manufacturing into an exact science.

These are the new craftsmen—the men-on-the-line in a space-age world.

North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

The Countdown

WASHINGTON

Official X-20 Schedule: 1966 Orbits

Flight schedule for the Air Force's *Dyna-Soar X-20* hypersonic research vehicle is now 1965 for air drops from a B-52 and 1966 for orbital shots. Official weight figure for the glider has now changed from "about 10,000 lbs." to "over 10,000 lbs."

Long Queue of Spacemen

NASA has received some 271 applications from aspiring astronauts. Breakdown includes: Air Force, 26; Navy, 34; Marines, 10; Army, 1; and civilians, 200. No indication has been given as to when selection of the next group will be announced, but it's not expected to take more than two or three months.

All Deliberate Speed

Final Congressional approval of NASA's Fiscal '64 budget is still at least two months away. House Space Committee still has not reported the authorization bill to the floor and will not do so until later this week. Appropriations Committee is waiting for a final House vote before starting its hearings and consideration of funds that NASA can actually spend. This is certain to take two or three weeks. In the Senate, the Space Committee completed hearings last week, but won't vote on the authorization bill until it clears the House. Senate Appropriations Committee in turn is waiting for its House counterpart to complete action before it begins deliberations.

Nike-Zeus Has Seven 'Announced' Intercepts

Army is always careful to use the word "announced" when discussing its *Nike-Zeus* intercept record. The score, the announced one, now stands at five *Atlas* targets and two *Titan I* targets. Overall, tests conducted so far in the program have been completely successful in more than half the attempts. Another 25% were partially successful.

SAINT Feasibility Flights Grounded

Scheduling of feasibility flights to prove out the concept of a satellite interceptor (SAINT) has been cancelled altogether. Emphasis in the program now rests on development of advanced sensors able to operate in the space environment for extended periods within reliability and accuracy requirements laid down by Air Force.

AF Pushing X-20 as Logistics Vehicle

Despite its single-pilot configuration, *X-20* is far better suited for logistic missions than *Gemini*, Air Force claims. The instrumentation bay behind the pilot is filled with gear during research flights, but during operational flights it could hold four men, COUNTDOWN has been told. These four men, or equivalent cargo, could be ferried to and from orbiting stations with greater ease than a ballistic capsule such as *Gemini*. Additionally, none of the four would have to know how to fly the vehicle back to Earth, since the *X-20* pilot would stay aboard. In a *Gemini* ferry mission, the vehicle could hold only two men, and these would be required to know how to handle the vehicle. This latter consideration, AF says, puts a serious crimp in any plans to rotate scientists between Earth and an orbiting station on a regular basis.

Somebody Talked Too Soon?

Air Force sources are now quietly declining to discuss plans to set up a series of bases for recovery of aerospace vehicles (M/R, June 10, p. 34; M/R, July 8, p. 14). One source commented that "someone apparently talked too soon," about the selection of Edwards, Holloman and Wendover AFB's as recovery sites. The resulting M/R disclosure caused a fiery reaction from some interested Congressmen, putting the lid on such plans.

INDUSTRY

Pratt & Whitney Building LEM Cells

Pratt & Whitney Aircraft Division of United Aircraft has been picked by Grumman to negotiate a subcontract covering development of fuel cells for the *Apollo* Lunar Excursion Module (LEM). The firm becomes the seventh major LEM subcontractor.

. . . And Studying Fluorine

P&W has also been awarded a 13-month NASA contract to study use of fluorine as a space fuel. Using a modified RL-10 engine, it will test a fluorine-oxygen combination as well as pure fluorine with hydrogen.

Stehling to EOS

Exodus of NASA senior staff members to industry following the departure of D. Brainerd Holmes may be accelerating. Kurt R. Stehling, chief of rocket propulsion in the Office of Plans and Program Evaluation, is leaving to join Electro-Optical Systems, Inc., as assistant to the president for astronautics. Others are reported ready to leave.

Bendix Typhon Work Boosted

Navy has awarded Bendix Corp.'s Mishawaka (Ind.) Division another $1.5 million for R&D on the *Typhon* ship-to-air-missile. This supplements an earlier $3.4-million contract.

INTERNATIONAL

European Satellite Group Reconvening

European Conference of Satellite Communications will resume meeting in London this week to discuss European contributions to developing global satellite communications. The organization met for the first time in Paris this May.

The Missile/Space Week

DOD Asks Fund Restoration

The Defense Department has entered a strong plea for restoration of funds cut in military R&D space activities, but expressed willingness to go along with most of the cuts made by the House Appropriations Committee last month.

In a letter to the Senate Defense Appropriations Subcommittee, Secretary Robert S. McNamara asked for a restoration of $44.6 million in the $59.6 million cut from the military communications satellite program. He said all the exceptions he had to the bill involved programs of paramount national security.

McNamara also asked the extension of a $125-million fund available to DOD for use in *Dyna-Soar* or Mach 3 aircraft to include "space vehicles" as well. As the bill presently reads, there is no provision for any other manned space program except *Dyna-Soar*.

A $5-million cut in a classified amount requested for the *Lance* missile should also be restored, McNamara said. No mention was made of a $100 million cut the House made in the *MMRBM* program.

Total amount the Department of Defense has asked to be restored is $684.2 million in an almost $2 billion budget cut. If a suggested lowering of statutory working capital fund levels is approved by Congress, the Secretary said, the amount needed to be restored could be lowered to $437.2 million.

Moon Shelter Study Awarded

Armour Research Institute has been given the job of designing a portable survival shelter to be landed on the Moon ahead of the first astronauts.

The $28,000 study, supervised by Edward L. Hays of Crew Systems at the Manned Spacecraft Center, will consider the shelter, equipment, and supplies needed for periods of two, six, and ten days.

Hays specified shipment to the Moon in a single rocket load, with shelter components packaged for transport easily by one man.

Communications and power should be sufficient for contacting the orbiting *Apollo* mother ship and the Earth control center. Shelter erection should be as automatic as possible.

In addition to protection against hazards of the lunar environment, the shelter will provide spare parts for space suits, repair and first aid kits, food, water, and extra clothing, and a fuel-handling suit in case refueling work is necessary on the Lunar Excursion Module.

Symposium To Draw 3000

More than 3,000 representatives from the aerospace industries are expected to attend the Second Industry Assistance Symposium at Houston July 30.

The Symposium—sponsored by the NASA Manned Spacecraft Center and the Houston Chamber of Commerce—will be held at Rice University.

MSC will conduct morning and afternoon panel discussions on procurement methods, display space-age hardware and hold question and answer sessions on these items.

The panel discussion will cover procurement methods in Research and Development, construction, Modification, Test Facility and Services Support, and Product and Equipment Reviews.

Orbiting Apollo Studied

The Manned Spacecraft Center for the first time has specified a two-gas atmosphere for the *Apollo* spacecraft system, which begins to look more and more like NASA's all-purpose space vehicle.

Consideration of a nitrogen-oxygen mixture was made a part of the sole-source contract awarded North American Aviation last week. The design study calls for converting the three-man, 14-day *Apollo* spacecraft to a small, Earth-orbiting space station in which two or three men can live for four months.

The *Apollo* spacecraft system already is undergoing a series of studies that would equip it to:

1) Ferry 6-12 men between Earth and orbiting space station laboratories.

2) Carry 10,000 lbs. or more of supplies and cargo to re-supply the space station.

3) Perform lunar reconnaissance missions through a module equipped for photographic, radar, and infrared mapping.

4) Launch a dozen or more instrument packages from lunar orbit down to the Moon's surface to provide close-up measurement of a potential landing site east of Copernicus.

Space officials had discarded a two-gas system for the *Apollo* lunar expedition because of the simplification and weight savings possible with oxygen alone. Tests from MSC and Johnsville, Pa., proved that for the relatively short 14-day Moon-mission time the crewmen would not experience the lung condition called atelectacis, reported by British experiments with oxygen alone.

Pressures would be in the 0.5 to 1 atmosphere range.

The latest extended mission study covers using the *Apollo* command module for living quarters with a minimum of modification. North American will also consider ways to convert part of the service module into living quarters, provided the crewmen can have access to the command module at all times.

Since the contemplated Earth-orbital missions are much simpler than the lunar flight, considerable savings in weight and space can be achieved by removing much of the lunar navigation equipment, heat shielding, and other gear, said E. H. Olling, head of the MSC Space Station Project Office.

A special mission module also is a part of the consideration given *Apollo* as a space station. All components must provide tradeoffs between radiation shielding and fuel needed to keep the spacecraft oriented in orbit, including maintaining orbit despite atmospheric drag.

MSC wants the extended *Apollo-Saturn* combination to be able to dock and rendezvous with another spacecraft in the extended *Apollo-Saturn* configuration.

Shots of The Week

The Air Force's *Minuteman* solid-fueled ICBM went one for two this week with a successful launch July 12, followed by an in-air explosion on the 16th. The first flight, from Vandenberg AFB, Calif., flew 5,000 miles down the Pacific Missile Range. The failure occurred 5 seconds out of a Cape Canaveral launch silo.

Other shots of the Week:

- A *Titan* ICBM was successfully launched July 16 from Vandenberg AFB, Calif., by an Air Force crew.
- The 44th firing of the Air

Force's *Mace* tactical missile by the 4505th Missile Training Wing at Orlando, Fla., July 18 was termed a "complete success."

- An Army *Nike-Zeus* antimissile missile, fired from Kwajalein Island July 12, intercepted an Air Force *Atlas* on a 5,000-mile trajectory from Vandenberg AFB, Calif. The success was the seventh such intercept by the *Nike-Zeus*.
- The Air Force launched a secret satellite July 12 from Point Arguello, Calif. The shot employed an *Atlas-Agena* booster.

Telstar II Quits 'Talking'

Attempts to coax *Telstar II* back to life were unsuccessful late last week after the AT&T satellite quit transmitting during its 451st orbit July 17.

Initial efforts to command the satellite from the Andover, Me., ground station failed, but technicians continued to try to communicate with it.

Telstar II, launched May 7, functioned normally on its 450th orbit over Andover late on July 16, and telemetry signals were later picked up by NASA's Johannesburg, South Africa, station. Minutes later, the NASA station at Woomera, Australia, was unable to pick up a signal on the satellite's 136-mc frequency.

The last telemetry data recorded by the Johannesburg station is being analyzed by Bell Telephone's Murray Hill, N.J., labs, and other efforts will be made to determine the trouble source.

DEW Line Being Dried Up

About 28 small Distant Early Warning (DEW) line stations are expected to be discontinued under an agreement by the U.S. and Canada. The stations, discontinued because of improved coverage gained by other stations, will leave no gap in the line.

Adjustments in the configuration of other DEW line equipment were made following a re-appraisal of the line's effectiveness.

There will still be "acceptable" early warning of attack, the Pentagon said. Of the stations, 20 are in Canada and eight in Alaska, with a personnel total of about 183 Americans and Canadians.

The thinning out of the line is viewed as further evidence that a massive air attack against the North American continent is considered increasingly unlikely.

Expanding Activity in ROCKETS Creates New Positions with Bell Aerosystems Company

COMBUSTION DEVICES

Development Engineer to design liquid rocket injector systems and to evaluate current designs and project future requirements. BS or advanced degree in ME plus 5 years experience in liquid rocket injection systems. Salary to $15,000.

STRUCTURES

Senior Engineer to direct the activities of a small group of structures engineers in design analysis of complex structures, shells and pressure vessels. Work will be oriented toward structural analysis of liquid propellant rocket engines, turbine pumps, thrust chambers, valves and components, using computer programming of solutions on IBM 7090. BS in AE, ME, CE or Engineering Mechanics required, coupled with 5 to 10 years related experience, and proficiency in application of analysis methods, basic shell theory, theory of elasticity, elastic stability and thermal-structural analysis. Salary to $15,000.

PROPELLANT TRANSFER

To engage in design and development of liquid rocket propellant transfer systems and equipment, and to evaluate current positive expulsion devices and project future requirements. Requires BS in ME plus minimum 3 years experience in design of lightweight pressure vessels. Salary to $12,000.

TEST FACILITIES

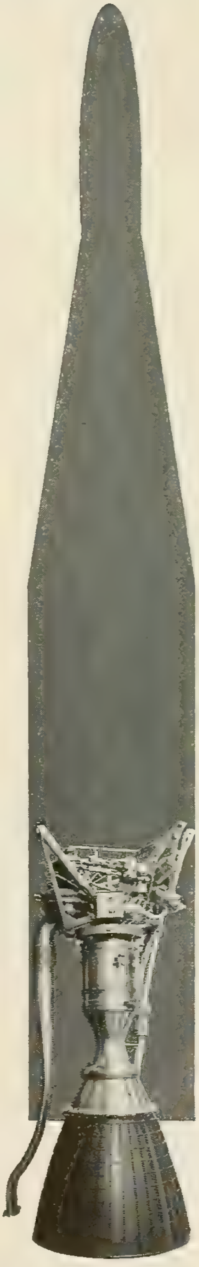
To assume responsibility for rocket test center involving modification and evaluation of current facilities, and assisting in expansion and design of new facilities for testing liquid propellant rocket engines. BS in ME or equivalent plus 5 years experience in mechanical design of piping systems, facility construction, plant layout and field liaison, preferably in the rocket propulsion area. Salary to $12,000.

Bell Aerosystems Co. will provide the primary rocket propulsion (with the Agena engine) and the secondary propulsion system for the Agena D target vehicle with which the 2-man Gemini spacecraft will rendezvous. Bell's AGENA rocket engine has injected into orbit more satellites and more weight than all other U.S. rocket engines combined.

Bell has also developed the reaction controls for Project Mercury and other space vehicles, the first rocket belt for man in free flight, and a zero-gravity belt for man's use in outer space.

Current investigations include very high energy rocket engines, development of a multiple re-start engine, and new applications for advanced rocket engines.

Resumes are invited from Engineers qualified for positions in one of the areas listed above. Please address Mr. Thomas Fritschi, Dept. C-27.



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Both NASA and DOD . . .

U.S. Space Management in Flux

New Pentagon office headed by Hall will manage programs destined for space roles; STL to study NASA practices

TOP-LEVEL management changes in the National Aeronautics and Space Administration and Dept. of Defense are expected to have a sharp impact on the nation's space programs.

In the space agency, the changes have been portended by the selection of Space Technology Laboratories to make a study of management of NASA's manned spaceflight programs.

The study follows the "forced" resignation of D. Brainerd Holmes and the establishment of Administrator James E. Webb as NASA's space czar.

In DOD, the new office of Deputy Director of Defense Research and Engineering for Space Technology, headed by Dr. Albert C. Hall, has been set up as the primary management office for any program headed for a space application.

Included will be such programs as the *Titan III*, a *Manned Orbiting Space Station*, and the large solid motor project.

Not included will be programs well along in development—such as *MIDAS* and *SAMOS*—where management will not be changed.

In addition, Dr. Hall, who will assume his new position on Aug. 1, will have overall responsibility for pulling the DOD space program together and acting as its spokesman within DOD and in the increasingly important relationships with the space agency.

Setting up of the new office brings into sharp focus the growing importance of the military space program. The position, currently filled by Dr. Lawrence L. Kavanau, previously had the rank of only special assistant to Dr. Harold Brown, Director of DDR&E.

- **NASA management**—While the space agency's management changes are not as advanced as DOD's, the STL study indicates they are clearly on the way.

The NASA announcement said the study would be conducted "in connection with organizational changes necessitated by the completion of the *Mercury* program and the focusing of effort on *Gemini* and *Apollo* to achieve the earliest possible flight date."

Webb's move to enlist the aid of STL followed sharp criticism by both space agency and Administration officials of his present management concept, which leaves no room for a "strong manager" as director of the Office of Manned Space Flight.

These officials claim that Webb's approach will result in scheduling delays as well as higher costs.

One expected result from the study is that NASA's field centers will be given more responsibility for direction of the manned spaceflight industrial team. This was indicated by the NASA announcement, which said one of STL's jobs will be to "increase the effectiveness of the relationships between various NASA centers and industrial contractors."

Dr. Edward Doll, STL vice president who will direct the study, will be assigned to NASA headquarters until completion of the six-month contract worth $30,000.

The firm was ordered to utilize its past experience of management of large ballistic missile programs in assessing what recommendations will improve current management of *Gemini* and *Apollo*.

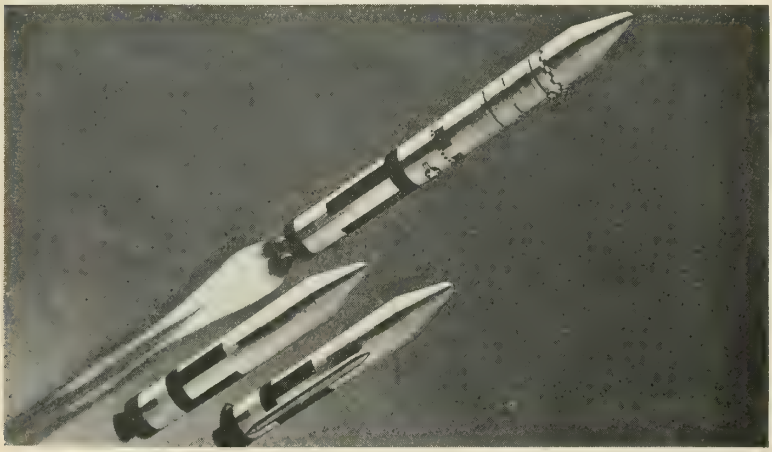
STL serves as systems manager for the Air Force over the *Atlas*, *Titan* and *Minuteman* ICBM programs despite the fact that each system has an industrial firm as major contractor.

This could mean that NASA is considering setting up a systems manager industrial firm for its manned spaceflight activities.

Even if no changes result from the STL study, the resignation of Holmes has made it clear that Webb intends to make his own decisions based on the advice of many officials rather than the recommendation of one person heading the Office of Manned Space Flight. This is expected to increase the authority and power of the directors of the three field centers involved in Projects *Gemini* and *Apollo*—Manned Spacecraft Center, Marshall Space Flight Center and the Launch Operations Center.

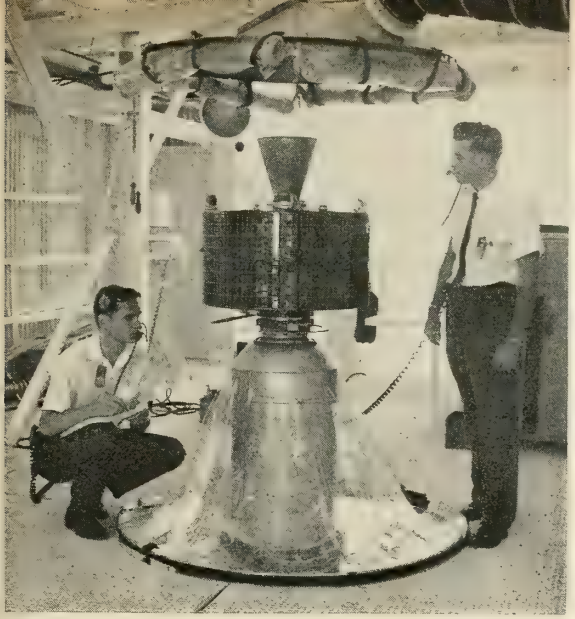
- **DOD reasoning**—In addition to the new seriousness with which DOD views space programs, establishment of the new office apparently also stems from the loss of John H. Rubel, who served simultaneously as Assistant Secretary of Defense and Deputy Director of DDR&E.

Rubel primarily concerned himself with the DOD space program. The new office is expected to take up the slack created by his departure. ■



Titan III Drops Its Solid Boosters

ARTIST'S DRAWING shows two solid-fuel UTC boosters for Air Force Titan III standard space launch vehicle dropping away from Martin Titan II core vehicle. In latest contract announcement, Moog Servocontrols, Inc. won awards totalling $1 million for steering controls for all three liquid-propelled stages of the core vehicle.



TECHNICIANS at Cape Canaveral mate 147-lb. Syncom II active repeater communications satellite to third stage of its Douglas Delta launch vehicle. New satellite has been heavily modified from Syncom I.

Second attempt . . .

Modified Syncom Ready For 22,300-mi. Orbit

by Hal Taylor

NASA IS READY to launch a modified *Syncom* communications satellite in an attempt to achieve the first successful satellite operation at a 22,300-mi.-high, near-synchronous orbit.

The flight—scheduled for no earlier than July 23—will be made from Cape Canaveral with the Douglas *Delta* booster.

The new satellite is the second in the *Syncom* series. *Syncom I*, launched Feb. 14, 1963, achieved a successful orbit, but radio contact was lost during insertion into synchronous orbit.

Although the cause of the malfunction has never been pinpointed, space agency officials believe it stemmed from either an electrical or nitrogen tank failure.

- **Some changes made**—As a result, *Syncom II* has been extensively modified:

—A small silver-zinc battery has been installed to supply power to operate a second beacon and telemetry system for about 30 to 40 minutes—after the apogee kick motor is fired—in the event of a failure in the primary power supply.

—The power distribution system has been changed so that there are redundant paths for power to each system.

—An accelerometer has been installed to measure acceleration levels during burning of the apogee-kick motor.

—A Jet Propulsion Laboratory Starfinder solid-propellant motor is being used instead of the Thiokol TE 375 employed in *Syncom I* for the apogee-kick stage. The JPL motor is specifically configured for the *Syncom*, while the Thiokol motor was adapted from a motor designed for another use.

—Clearances between the nitrogen tanks and the spacecraft structure have been increased to avoid contact and possible damage to the tank and structure by forces encountered from vibration during the apogee-stage firing.

- **The plan**—If successful, *Syncom II* will be capable of performing two-way telephone, teletype and facsimile transmission, but not television. Communications experiments will be conducted between two stations of U.S. Army Satellite Communications Agency (SATCOM) under the direction of NASA.

One station—USNS Kingsport—will be anchored in Lagos harbor, Nigeria. The other terminal, located at Lakehurst, N.J., Naval Air Station, is made up of 11 wheeled vehicles which can be transported anywhere in the world.

Syncom will be launched by the three-stage *Delta* to an altitude of 140 mi., where the spacecraft will go into an elliptical orbit. Some 5¼ hours after insertion into orbit, the apogee-kick motor will be fired to achieve the 22,300-mi. synchronous orbit. Once the high orbit is reached, hydrogen-peroxide and nitrogen gas control systems will be used to move the satellite to the desired position, longitude 40 degrees west, over the Atlantic Ocean between Africa and South America.

If everything goes well, the satellite will achieve the desired longitude in 18 days. It is expected, however, to be in position for communication tests about eight days after launch.

- **The satellite**—*Syncom*, without antennas or apogee motor, is a cylinder 28 in. in diameter and 15½ in. high. The apogee-motor rocket nozzle protrudes from one end, communications antennas from the other. Weight of the spacecraft, including the apogee-motor case with all the fuel gone, is 86 lbs. Payload weight is 147 lbs. at separation from the third stage of the *Delta* launch vehicle.

The side surface of *Syncom* is covered with 3,840 silicon solar cells, which supply energy to the nickel-cadmium batteries.

The satellite's outer structure supports the solar panels and contains the nitrogen and hydrogen-peroxide gas control systems and most of the satellite's electronics. An inner structure supports the apogee motor and the remaining electronics.

Antennas include a slotted-array antenna for communications transmission, a dipole for communication receiving, and four whip antennas in a turnstile arrangement for telemetry and command.

Syncom has a passive temperature-control system. Adequate temperature control is achieved by the design and choice of materials used on the external surface and by properly insulating subsystem equipment.

For control in orbit, the nitrogen and hydrogen peroxide are contained in two pressurized spherical tanks mounted opposite each other and connected by a manifold.

Each control system has two jets. One fires parallel to the spin axis and the other perpendicular to the axis. The nitrogen system contains about 1.7 lbs. of nitrogen at 2,500 psi, and the other system contains 5 lbs. of 90% hydrogen peroxide pressurized to 200 psi by nitrogen. The nitrogen system has a total correction capability of about 47 fps, and the hydrogen peroxide system has a correction ability of 300 fps. ■

In Senate testimony . . .

NASA Warns of Risks In House Budget Slashes

by Heather M. David

NASA officials say the *Apollo* Moon landing program will be delayed from four to six months if the Senate goes along with the House bill cutting almost $490 million from the space agency's FY 1964 budget.

In addition, a number of risks in program reliability and astronaut safety will have to be taken if the cuts go through. Spokesmen for the Office of Manned Space Flight said the $120 million-cut in the agency's requested $1.2 billion for *Apollo* would hold ground-testing to a minimum.

The $5.7-million cut in the aerospace medicine program's requested $16.7 million will require that spacecraft design freezes be accomplished without all the equipment and human factors data needed, the spokesmen said. "This action could result in use of equipment that will not adequately support the life of the astronauts, and thereby cause a delay in the overall *Apollo* schedule," they said.

Top NASA officials, led by Administrator James E. Webb, appeared before the Senate Space Committee last week to argue for restoration of funds cut by the House Science and Astronautics bill, still pending in the House.

Chairman Clinton Anderson (D- N. Mex.) told MISSILES AND ROCKETS the group will be ready to vote as soon as the bill is cleared by the House. He declined to comment on how much the Senate might restore to the NASA budget, but other observers said that the committee seemed to be reacting favorably to the NASA executives' arguments. Among the programs the agency has indicated it is fighting for:

—All manned spaceflight programs, test facilities and support equipment.

—*Surveyor Orbiter* program—which was completely wiped out in the House committee vote. While some recommendation was made that an *Apollo* be used to gather data on the Moon before a manned landing, Space Sciences spokesmen said 10 *Orbiters* could be launched for the cost of one *Apollo*, and *Orbiter* would have greater flexibility and quite adequate resolution.

—International studies program (follow-on), for which negotiations have already been made with Great Britain and France.

—The FIRE flight program on interplanetary re-entry—which was completely eliminated in the House committee recommendation. NASA spokesmen disagreed that this program could be postponed.

- **Manned spaceflight programs**—Besides the *Apollo* spacecraft and space medicine funding, a $28-million slash in integration and checkout funds ($153 million requested) will have direct effect on acceptance testing of *Apollo* spacecraft and also affect the flight schedule, spokesmen said.

The reduction by the House in M-1 engine funds from $45 million to $15 million will mean virtually a complete stoppage of work on major components and complete engines. The spokesmen pointed out that personnel level at Aerojet-General and several subcontractors is now at 95% of the peak level for the M-1 program, and a cutback now will mean a loss of efficiency and an 18-month delay in the engine development program. The agency also indicated that the delay would cost between $15 and $20 million more in the long run.

Slashes in funding for a number of construction projects will significantly delay launch schedules of the *Saturn* series, the spokesmen said. A $25.4-million cut in Complex 39 funds (total requested $217,219,000) will seriously jeopardize the agency's ability to complete the complex in time to support the initial launch of *Saturn V*, they said.

The deletion of test stand funds for static-testing of *Saturn* stages will delay development and acceptance-testing programs at the Mississippi Test Facility, the agency said. Most of the money is needed for contracting this year to meet schedules.

A proposed $3.5-million cut in LEM facilities ($15 million asked) at White Sands Missile Range will force the deletion of one test stand and associated equipment, NASA said, and would have the effect of either delaying the lunar landing program or requiring the use of less reliable engines.

At Marshall Space Flight Center, a $9.5-million cut in the $38.5-million request will eliminate a badly needed high-pressure gas and propellant systems facility—said to be necessary from both a safety and efficiency standpoint. NASA spokesmen also said the agency was urging restoration of $1.3 million cut from the Michoud operation's request, since part of the funds will go toward building an airstrip so that equipment need not be transported from the New Orleans Municipal Airport 12 miles away.

- **Space Sciences**—Edgar M. Cortright, Deputy Director of the Office of Space Sciences, told M/R his office could accept a number of cuts without setting back its program, except for the *Surveyor Orbiter* and International Studies portions.

He said Space Sciences is pushing strongly for the *Orbiter*, which now is programmed to be launched by an *Atlas-Agena* in the last half of 1965. He pointed out that the *Orbiter* is the only system giving a wide area coverage—more than 500,000 times that of *Ranger*, with 1-meter resolution, and is suited to a number of tasks.

Contrary to general impression, NASA does have firm commitments to the follow-on international studies, and deletion of these funds would leave Great Britain and France holding hardware for which there were no vehicles, he indicated. This $4 million program the House deleted entirely.

The $25-million cut in the *Ranger* program and the $15-million cut in the *Mariner* program are acceptable to the agency since they coincide with internal reorganizations of these programs, Cortright said. He also said that a $14-million cut in the Biosciences programs—primarily affecting the *Biosatellite* program, will delay that program by about six months but will not reduce its scope or usefulness, since it is a long-term investment.

- **OART programs**—Spokesmen for the Office of Advanced Research and Technology say they are hoping for a complete restoration of funds cut by the House from its program. Loss of the $8.5 million in the FIRE program will cause a delay in ability to make timely technological decisions about the whole next generation of vehicles, spokesmen said.

A $5-million cut in the $18.2 million requested for Human Factors programs (Biotechnology and Human Engineering) would wipe out or significantly reduce over 90 individual research tasks, the spokesmen said. The agency also asked for restoration of a $5-million cut in the *Rover* program, since NASA already had adjusted its budget to reflect the delays in the program. All of the $96.7 million request is thus essential, NASA said. ■

MA Know-How May Be Boon for Future

Workshop seeks to pass on to new projects high reliability achieved in Atlas boosters

by Russell Hawkes

San Diego—A postmortem on the high reliability of *Atlas* boosters in the *Mercury* program indicates that the management techniques involved can be fruitfully applied to other major space programs.

The lucid communication between *Atlas* management and every working echelon was praised during a one-day *Mercury-Atlas* reliability workshop here cosponsored by the Air Force, NASA and General Dynamics/Astronautics. Purpose of the gathering was to transfer the managerial know-how gleaned from the project to future programs.

Walter C. Williams, NASA *Mercury* operations chief, said that for all its technical importance, *Mercury* was equally significant as a management exercise to originate new techniques needed in developing manned space systems. It is apparent that shoddy workmanship has been a serious detriment to reliability in missile and space systems; *Mercury-Atlas* management techniques for obtaining quality work may prove to be one of the most important results of the program.

An Air Force spokesman, noting the emphasis on safety and reliability in the program, said that half the man-hours spent by the service in procuring *Mercury* boosters was devoted to meeting these goals.

Williams told Missiles and Rockets the fundamental points brought out in the meeting were always apparent to good managers. However, he said, the sheer mass of people involved in space projects requires that the *ad hoc* managerial techniques of the past must now be formalized.

Differences between perfectly acceptable management techniques can create confusion and inefficiency in a program which is on the scale of *Mercury, Gemini* and *Apollo*.

- **Sense of urgency**—The vital importance of communicating motivation to workers at every level was constantly reiterated to the approximately 300 management officials from some 40 major space companies who attended the meeting. Speakers also expressed the fear that it may be hard to sustain this drive on more routine space flights.

J. R. Dempsey, president of GD/A, said this top-to-bottom sense of urgency is best communicated by face-to-face contact and by actions, not posters. He noted that when visiting astronauts toured the GD/A plant and talked to workers about their jobs, the improvement in the quality of work was immediate and dramatic. The strong sense of responsibility for human life is felt to be a main reason for the 100% reliability of the *Mercury-Atlas* manned vehicles.

Dempsey's list of important ways to achieve reliability included:

—Agreement on the nature of the program. Where this agreement is lacking, groups working at cross purposes make reliability prohibitively expensive in time and money.

—Top management attention. This is part of Dempsey's communication-by-action thesis. He told M/R that "wall posters and decals will not bring reliability unless workers see top management out on the plant floor striving to get it."

—Identification of the man with his work. This should be done not only to eliminate substandard workers but to reward successful ones. "At the beginning of the program, we found that the only guy who ever got any attention was the guy who broke something or dropped a gyro," Dempsey said.

—"Tiger Teams." GD/A formed technically balanced teams of senior supervisory engineers to follow each launch vehicle to the Cape to insure that design intent was executed without deviation at every step. Their opposite numbers from the staff at the Cape were brought to the plant for an early introduction to each vehicle and to bring together the initial designers and the launch crew. The top-notch designer teams normally worked about 15 hours a day at the Cape, since they could not return to their homes in California till the job was done. Thus were they named "Tiger teams."

- **End of fall-out**—Early in Project *Mercury*, engineers and officials worried about the hazards of lifting a man into orbit with a weapon system like *Atlas*. The concept of reliability in an unmanned weapon system is a statistical one expressed as target kill probability rather than as the successful operation of individual vehicles. Now that *Mercury* is finished, experienced men are worrying about the hazards of using launch systems which are *not* adapted from a weapon system. There will be no more cost-free confidence flights occurring as the natural fall-out of missile development. To make up for this lack will take ample funds.

To capitalize on the weapon system background of *Atlas*, program management insisted upon rigid control of design changes. Speaking from experience, *Mercury-Atlas* managers also advise their successors to discourage uncontrolled trouble-shooting, quick fixes, and improvised modifications. Everything that may alter the hardware must receive the benefit of top design talent if reliability is to be assured.

Dempsey said reliability, low cost, and adherence to schedules are, to some extent, trade-offs. Obviously, there will be pressure to cut the number of costly and time-consuming confidence flights. Williams disagreed with Dempsey's view that extreme measures to obtain reliability can hurt schedules. He pointed out that each of the two failures of unmanned *Mercury-Atlas* systems caused a six-month schedule slippage. This is consistent with airplane flight-test experience, which has shown that a crash stretches schedules from four to six months. If fatalities are involved the delays tend to be longer than if there are none.

During the adaptation of the *Atlas* weapon system to the *Mercury* job, GD/A began the practice of holding error analysis sessions with workers who were responsible for faults to prevent recurrence. The sessions produced a 40-50% reduction in errors, said USAF Col. R. H. Brundin, a human factors specialist. Brundin predicted that upcoming programs can expect to meet opposition to the management techniques for obtaining quality workmanship. He said a yardstick for worker motivation would be a boon to management, but difficult to find. ■

'I'm not kidding myself . . .'

McNamara Details DOD Cost Cuts

Says program is 'real revolution' in contracting; estimates $4-billion annual savings possible

ANNUAL SAVINGS of $4 billion are possible through the cost-reduction program set up by Defense Secretary Robert S. McNamara, without any reduction in U.S. force levels.

This appraisal of the Pentagon's efficiency campaign was given by the Secretary himself as he laid out examples of defense contracting improvements resulting in an overall savings of 25 cents on each dollar. The actual dollar saving for Fiscal Year 1963 amounted to more than $1 billion, compared with the anticipated saving of $750 million which DOD cost experts predicted.

At a recent news conference, McNamara brought along actual hardware for newsmen's examination. He candidly discussed defense contracting procedures and how he hopes to alter them for greater efficiency and less cost.

Prime reason for the high level of savings is the three-pronged nature of the program set up last July: (1) buying only what is needed; (2) buying at lowest sound prices; (3) reducing operating costs through integration and standardization.

Explaining his confidence in the validity of the savings, McNamara said it is very easy to delude oneself about the amount of money saved on complex systems.

"To avoid self-deception, I've assigned 19 auditors to this program to check the figures. I'm not kidding myself, I'm not kidding you, and my people are not kidding me," he told newsmen.

- **Chapter & verse**—The Defense Secretary said the savings result from efficiency alone, not changes in force levels. To back this up, he cited examples of cost reductions in the missile field:

—*Bullpup missile*—Sole-source price in 1961 was $4,058 each. The competitive procurement price for the same year was $2,686 each, the 1962 price dropped to $2,448 and the 1963 dropped further to $2,105. Net result of switching from sole-source to competitive procurement, McNamara said, was a saving of $25,995,078 for the three-year period.

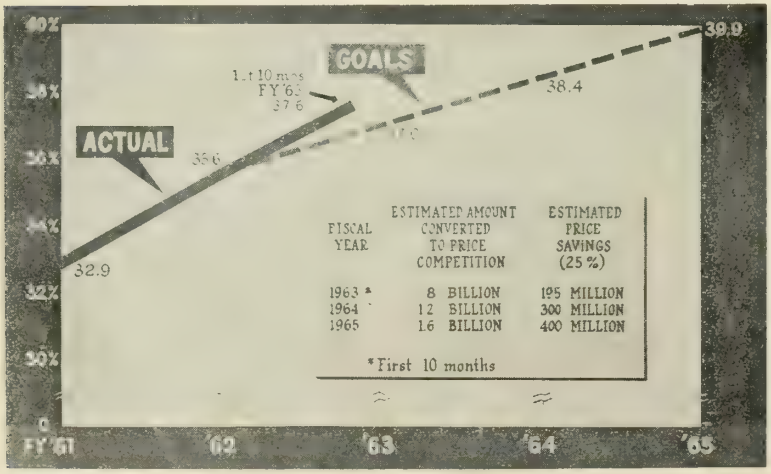
—*Explosive switch for Terrier*—Sole-source procurement price was $65.36, while the competitive procurement price dropped to $30.00. Net result for Navy's purchase of 1,000 units was a saving of $35,360.

—*Pershing air vane*—Elimination of "gold-plated specifications" caused a change in the *Pershing* attitude-control vane fabrication—from a foam-filled plastic skin to an aluminum casting with an ablative leading edge. The original design called for a special fitting, the revised design did not. Total saving calculated by DOD was $1,140,000 for this item alone in FY '63.

—*2.75-in. rockets*—Re-utilization of surplus supplies led to the Air Force supplying the Army with $51,234,382 worth of 2.75-in. rockets for use on helicopters. The AF considered the supply as surplus material. The Army had an urgent requirement to arm its helicopters in Southeast Asia. Therefore, the Army spent $10 million modifying the weapons for its own use, avoiding a hasty $40,759,382 procurement of the same item.

—*Minuteman silo mule*—A device for opening and closing the *Minuteman* silo hatch during maintenance and other operations cost $555,000 originally. After re-design, it cost $80,800, for a total saving of $1,200,000.

Overall savings due directly to changeover from sole-source to competitive procurement of missile com-



FISCAL YEAR	ESTIMATED AMOUNT CONVERTED TO PRICE COMPETITION	ESTIMATED PRICE SAVINGS (25%)
1963 *	8 BILLION	195 MILLION
1964	1.2 BILLION	300 MILLION
1965	1.6 BILLION	400 MILLION

*First 10 months

CONTRACTS awarded on basis of competition as a percent of total contract awards.

ponents and parts during the first 10 months of FY '63 amounted to $24 million, DOD said. Another $40 million was saved in communications equipment and electronic procurements.

- **Exceeds expectations**—When the DOD cost-reduction program was laid out last July, it was estimated that unnecessary expenses could be wrung out of defense contracts to the tune of $3 billion per year within five years, and that 25% of that goal would be realized in FY '63. When $1 billion was saved in FY '63 alone, instead of the anticipated $750 million, McNamara concluded that the annual savings could be increased to $4 billion within five years.

He emphasized, however, that the savings will probably not decrease the overall defense budget, since increased pay and allowances for military personnel will make up the difference.

One of the areas most vulnerable to cost-cutters appears to be the sole-source procurement contract. Another is the cost-plus-fixed fee (CPFF) contract. Asked how a company can be expected to cut up to 60% of the cost of an item to meet competition and still survive (which one firm did on a communications item), McNamara said:

"When a plant manager's job depends on his cutting costs to meet competition, he'll cut costs."

He conceded that the company which cut 60% of the communication set's cost was an outstanding example, but he said he used it as a means of getting his concept across.

McNamara pointed out that the firm had supplied the item under a sole-source contract for $2,278, and the first competitive session produced 27 bids, with a low bid of $843. Ironically, McNamara said, the producer that turned in the low bid was the same one that had had the sole-source contract. He declined to mention the firm, but the radio set in question bore an RCA label.

In order to compete in the wide-open procurement session, McNamara continued, the firm turned the job of competitive bidding over to one of its commercial divisions, instead of the military products divison which had handled the sole-source contract. The commercial division, accustomed to competition, produced the same set with far less cost but without any loss in quality. McNamara emphasized that there were no gimmicks in the 60% cost-cut—no R&D expenses were included in the original $2,278 figure, and there were no unusual problems in the two procurements.

On the other hand, he was quick to add, no excessive profits or inefficiency marked the sole-source procurement of the same set.

"I've worked under these CPFF contracts from the other end of the defense contracting equation, and I know exactly what is happening in these cases," he said. "There is no incentive for either government or industry to reduce costs." He reiterated his oft-stated opinion that defense industry profits are too low, and added that any increase in those profits must be gained from incentive contracting, not by increasing the fee portion of CPFF contracts.

He stressed that cost-cutting without quality-cutting is "merely the application of that old principle—free enterprise." In the year since inauguration of his pet program, McNamara said, only one complaint had been received from industry about the concept. This, he said, indicates that companies can operate very effectively within the cost-reduction plan's framework. The results of the program so far indicate, he said, that a "real revolution" in the defense contracting field has occurred.

- **Rights to data**—Questioned about the controversy over rights to data developed under defense contracts, McNamara said there is very little R&D work done on major systems that the Federal government does not pay for. Therefore, the Federal government has a right to the information obtained under those R&D programs.

"The firms which produce the designs have a real head start on their competition in any future bidding to produce the system. This head start is all we owe them," he declared. He indicated that a firm which designs a system, then loses the competition to produce it, has not learned much about manufacturing its own designs.

- **Buy only what we need**—Spelling out his future objectives, McNamara said the best way to buy only what is needed to achieve a balanced readiness is to start at the beginning of the process—establishing requirements.

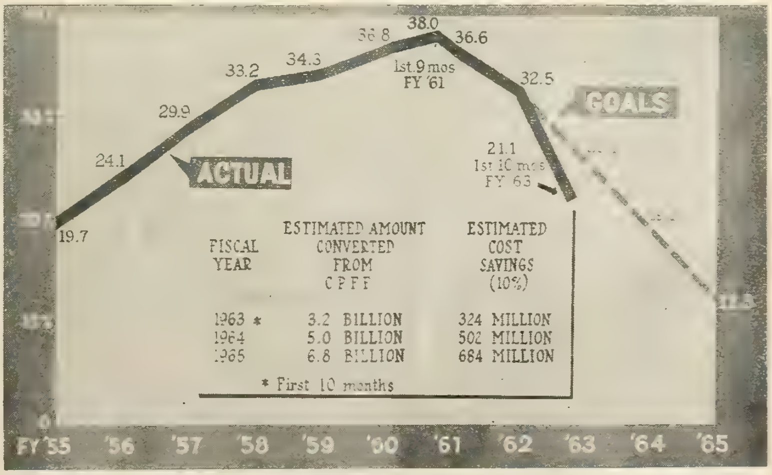
Re-utilization of excess inventories has also yielded considerable savings, he stated. During FY '63, nearly $1.2 billion in excess material and equipment held by DOD and its agencies was re-distributed to other military users for consumption or mobilization reserves.

Even though the $1.2 billion for FY '63 was $200 million over the rate of re-utilization for FY '61, the department hopes to increase it further—to $400 million over the FY '61 level—reducing new procurement accordingly.

A central clearing house now established at the Logistics Services Center in Battle Creek, Mich., will by year's end have a complete inventory of items available for re-distribution.

- **A million a week**—By eliminating "gold plated" specifications, McNamara said, the Defense Department is saving $1 million every week and expects this reduction in costs to triple during the next two years. Such elimination, he commented, includes cutting from procurement all costly materials and fabrication processes not essential to the proper functioning of the item being bought. The figures and examples he supplied to bolster his case for such Value Engineering were impressive, and his announced goals even more so.

- **Reduced operating costs**—Termination of unnecessary operations; standardization and simplification of procedures; and increasing the efficiency of the major services such as supply, communications, transportation and maintenance, are a third major area of DOD cost reductions. Elimination of unnecessary facilities (54 industrial plants are being sold), sale of excess real estate (265,905 acres have returned to civilian use), and similar moves have saved the department $316 million in the past two years. ■



FISCAL YEAR	ESTIMATED AMOUNT CONVERTED FROM CPFF	ESTIMATED COST SAVINGS (10%)
1963 *	3.2 BILLION	324 MILLION
1964	5.0 BILLION	502 MILLION
1965	6.8 BILLION	684 MILLION

* First 10 months

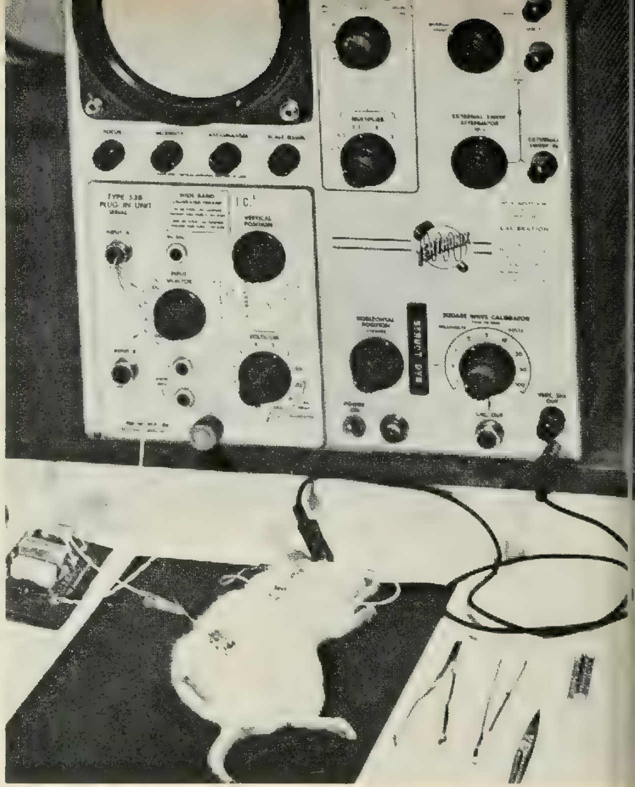
COST PLUS fixed fee contracts as a percent of total contract awards.

Using body electricity . . .

Electrical Device Implantation In Animals Studied

GE battery-less electrical power sources may be biomed breakthrough, find use as sensors in astronauts

by Heather M. David



TEST SETUP shows equipment checking bioelectric output of rat.

GENERAL ELECTRIC scientists are beginning a long-term testing program to perfect internally-implanted, self-powered electrical devices in the bodies of dogs and rabbits.

The devices, which utilize the bioelectric (oxidation-reduction) potentials present in all living creatures, could power implanted electrodes and report continuously on the state of the animal's electrocardiagram (EKG), respiration and other physiological parameters with little chance of malfunction, project chief Luther W. Reynolds told MISSILES AND ROCKETS.

Because there are no batteries in the system, it could transmit continuously—theoretically for the lifetime of the animal—with no need for recharging or for reopening the animal to replace batteries. In a recent Air Force study of a monkey with an implanted battery-operated sensor system, it took 4 hours to recharge batteries after every 2½ hours of transmission.

A big advantage of the system is that there is little chance of infecting the animals, because the skin is not pierced. In addition, the animal is not restrained by lead wires or even a vest or restraining clothing. Battery failure is eliminated.

Thus many of the problems of preparing and using animals for spaceflight research could be eliminated, GE researchers say. And the system may make the idea of implanting sensors in astronauts more attractive.

The idea grew out of GE's work at its new Space Sciences laboratory at Valley Forge, Pa., with biological fuel cells. The Physical Biology group, headed by Jack J. Konikoff, studied a number of means of producing electricity with living organisms.

Reynolds, one member of the group, has pursued this phase of the work. He recently received a one-year contract from NASA's Ames Research Center to concentrate on developing a power source for sensors and transmitters to be used with experimental animals.

- **Current tests**—During the next six months or year, six dogs will live in a new laboratory at GE with the miniature transmitters and electrodes implanted in their bodies. The entire system, designed by Julius Shatas of GE, measures only about 1 in. square and is wafer-thin. Each dog will transmit on a different frequency.

Reynolds said that a number of different materials will be used, and histological studies will be made after the tests are over to see whether drawing electricity from one place to another affects the tissues.

In the earlier tests, the group developed an experimental 500-kc oscillator for the system which was designed to run on somewhat less than max. 50 microamps at 0.25 v (12.5 microwatts). Power of 115 microwatts was measured at an emf of 250 millivolts at 480 microamps. Harry Freestone of GE was largely responsible for this electronics work.

Two electrodes were implanted in the rat's body. One was inserted beneath the skin, and the other, a platinum-black, was slipped into the abdominal cavity. Leads were connected from the rat to the oscillator and to an oscilloscope, which measured a voltage of approximately .35 to .40 volts.

On the other side of the laboratory, the researchers placed a receiver with a loud speaker. When the receiver was tuned to 500 kc, a clear signal was heard. Reynolds has run tests continuously for eight hours, with a stable transmission, and sees no reason why such transmission would not persist for the lifetime of the animal.

In the original test, the rat was killed by an intracardial injection of Nembutal. The researchers continued to measure voltage every 15 minutes on the oscilloscope, and found that it persisted up to 60 minutes after death, at which time 10 volts were recorded.

Platinum-black was chosen because it is a well-known catalytic material, but Reynolds said other types of electrode material will also be tested in the current tests.

The group has also carried out long-term tests with rats with surgically implanted electrodes to see how the materials used are tolerated. No ill effects have been reported, even after periods of six months. ■

echnical Countdown

ELECTRONICS

avy Pushes Microelectronics

A one-year study of integrated electronic circuits will be rformed by Motorola for the Navy with a view toward eir future exploitation in tactical command communica- ons hardware. Under the contract, the company's Military ectronics Div. in Scottsdale, Ariz., will also design and velop an "ultra-reliable tactical command UHF trans- iver," using such advanced circuit techniques, and test the uipment at sea. Following an approach long advocated by otorola's Executive Vice President Dan Noble, it is ex- cted that the program will probably be directed toward timate mergence of semiconductor integrated circuits and in-film technology.

ir Force Buys Litton ES Recorder

Litton Industries' electrostatic-recording process, Printa- ix, will be produced in an advanced form under a recently nnounced Air Force Rome Air Development Center con- act for possible use in future "L" systems. Developers, ata Systems Division, claim the instrument provides a ramatic improvement in the display of graphic, multi-color ata by large screen projection systems. Using transparent lm as the recording medium, the process stores each rimary color, backlighted with a strong light source having e optimum spectral response for that color. Introducing lmost no distortion, the technique permits projection of e data with high brilliance and color fidelity, the company isclosed. Recording, projecting, and erasing can be per- ormed continuously.

MR Cable Extension Completed

The new 716-mile underwater cable extension for the tlantic Missile Range (see M/R Jan. 14, p. 28) has just een completed ahead of schedule by U.S. Underseas Cable orp. The extension, consisting of two links—from Grand urk to Puerto Rico and from Puerto Rico to Antigua, was ompleted under two Air Force contracts totalling nearly 6 million. It will provide a 60-channel capability for andling real-time tracking and telemetry data from down ange stations. Due for completion by mid-August, the sys- em was completed nearly one month early.

New Laser Uses Suggested

The inherent stability of even a makeshift laboratory aser can be employed to detect movement of an object by s little as a single wavelength of light, scientists at the University of Michigan report. Using a "homemade" helium- eon continuous wave gas laser, the scientists stood the device on end to reduce strain and longitudinal curvative due to gravity, and mounted the laser mirrors on quartz rods to further improve stability. Such a device, researchers claim, will permit measurement of infinitesimal seismic movements, significantly improve Schlieren photography, and possibly permit measurement of ionized particles in a plasma.

PROPULSION

Tapco To Produce 156-in. Nozzles

A new tape-winding process which eliminates the need for huge pieces of equipment such as autoclaves will be used by Tapco Division, Thompson Ramo Woolridge, to fabricate nozzles for the 156-in. solid program. The contract, from the Manufacturing Technology Division of Aeronautical Systems Command calls for continued development of the process together with the delivery of a nozzle within a year. The process is capable of winding nozzles up to 300 in. in diameter. The AF award totalled only $611,000 but is regarded by Tapco as an indication of the potential in the nozzle fabrication field.

Minuteman X-Ray Ordered by Air Force

The ARCO Division of High Voltage Engineering is constructing a 25-million-electron-volt, L-band microwave linear accelerator for Hill Air Force Base. The powerful X-ray unit will be used primarily for scanning *Minuteman* motors. With a penetration power of 18 in. of stainless steel, the $350,000 device will easily pierce several feet of solid fuel in its constant search for voids and imperfections in the ICBM motors.

ADVANCED MATERIALS

LASL Studying "Meson Factory"

Physicists and engineers at Los Alamos Scientific Laboratory are making long range plans for a linear "meson factory" to be built at the lab early in 1970. The 1,800-ft accelerator would produce beams of sub-atomic particles such as pi-mesons, mu-mesons and neutrinos. Estimated cost of the unit runs to $20 million with another $25 million for buildings and supporting facilities. With a current rate of one milli-ampere and a calculated average beam power at the target end of 800 kw, the accelerator would far surpass anything presently planned.

Tungsten Forging Billets Available

Arc-cast tungsten metal ingots and forging billets are being marketed in development quantities by Climax Molybdenum Co. The billets are being produced in sizes up to 3.75 in. across, and turned ingots are available up to 8 in. diameter. The ingots have been extruded to sheet bars which have been rolled into a 0.050-in. thick sheet, 16 in. long and 28 in. wide, displaying good ductility and excellent surface quality. The ingots are suitable for both extruding and die forging but do not lend themselves to open-die upsetting.

Plum Brook Reactor Goes Critical

NASA's Plum Brook nuclear reactor went critical July 16th with actual high power testing slated for July 25th. Seven years in the making, the reactor is specifically aimed at testing systems and components for nuclear powered spacecraft. Two major experimental programs are on the immediate schedule at the $15-million facility. One, under contract to Lockheed Aircraft, covers the effects of neutron bombardment on samples of various alloys at cryogenic temperatures and the other program includes the monitoring of data sensors under radiation. The latter project will involve strain gauges, resistance thermometers and thermocouples. This program is in support of the KIWI nuclear reactor project under contracts with Westinghouse Electric Corp.

Cryopumps Go Commercial

A helium-cooled cryopump with up to five times the pumping speeds of ordinary units of comparable size is in commercial development at NRC Equipment Corp., subsidiary of National Research Corp. The unit can be used in any position and its speed is not restricted by connecting tubing. The helium-cooled surfaces tend to remove gases by condensation and the NRC unit operates at temperatures below —415° F.

How To Do Missile/Space Busine

NATO budget of $25 billion by 1967, expanding space effort beckon to U.S. firms, but American marketing won't work; European affiliation a veritable 'must'

by William Beller

AT A DIPLOMATIC reception held recently in the U.S. Embassy in Paris, a foreign industrialist complained to a visiting Air Force general about the uncooperative behavior of a U.S. contractor. Upshot: the U.S. company was assumed guilty and told to mend its ways.

The day after a highly secret NATO meeting in which requirements for new military equipment were drawn up, a Dutch electronics firm had a full report of the proceedings.

France enlisted U.S. aid to develop a missile able to compete for NATO business against a similar weapon already operational in the U.S.

These are some of the hazards of doing business in the missile/space field in Europe. Yet every day, knowledgeable U.S. companies are overcoming them and opening new markets there.

The payoff in view is a share of the defense budgets of the European NATO countries—$15.2 billion this year and an estimated $20-$25 billion by 1967. Another source is a growing European space budget, which is between $25 million and $30 million for 1963.

A U.S. company can get a steadily increasing share of the European business. But chances are that it won't get a penny's worth if it treats Europe as just an extension of the U.S. and tries to do business in the same old way.

The major trend taking place is toward cooperation with an established European firm—and away from wholly owned subsidiaries. This is not necessarily true of companies entering the commercial field in Europe but it's almost a necessity for the missile/space field.

This is the experience of top European representatives of U.S. companies as it was told to MISSILES AND ROCKETS in on-the-spot interviews.

- **Opinions at variance**—Opinion on how to do business in Europe, however, is far from unanimous. One version: "It's American know-how these people are after. They want us not only to give them everything we know but also make them a present of the hardware. The market is drying up."

Another: "The door is wide open if you affiliate with a European company, and there are many advantages."

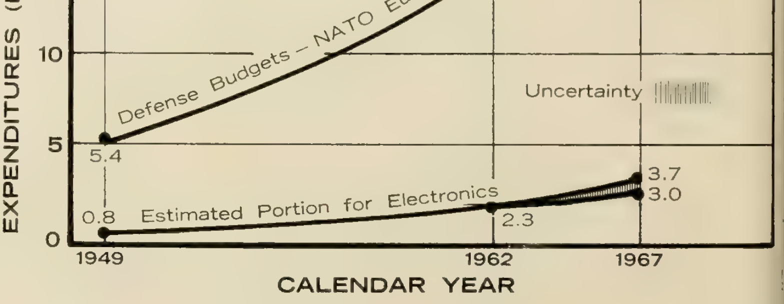
A third: "Direct product sales to Europe are out but we can sell technical assistance and then training, test equipment, maintenance and retrofitting."

During last month's Paris Air Show, the European staff of a leading U.S. missile/space company gathered in a hotel room and spoke freely of their problems to M/R. They also spoke optimistically of the opportunity to open new territories in Europe for their company—a job they have been doing successfully for the past five years.

"We're a hundred percent in the military business and therefore we can't build on a commercial base like General Electric or RCA," said their vice-president for European affairs. "Instead of dealing with other companies, we first have to deal with ministries in key countries that have funding and can appreciate our new technology."

Three years ago, these ministries were content with equipment that came out the previous year. They are more sophisticated today, and want the latest gear—but they are not prepared to pay for the R&D.

- **'Free' R&D**—They try to get around the R&D bill by tailoring their requirements to those of the U.S. and by putting their request in almost the day after the U.S. starts a program. "They figure that their only cost will be for the actual hardware," the sales manager said.



Europe

Next time join us!

"They still don't understand the weapons system concept," he complained. "They want to buy radar or an inertial system 'off-the-shelf,' even for a complicated vehicle. What they don't realize is that even in a jig-saw puzzle somebody had to make sure there is a complete picture before he begins sawing it into pieces."

Let's take an example in the space field, he said. Britain, Germany and France now are in the midst of setting up ground-based antenna systems for communications satellites. "So they go to the U.S. to get quotes on fixed-price contracts but with scarcely a thought about the difficulty of erecting such antennas, about 25 to 30 meters in diameter, and operating them—especially without systems management.

"Such a proposal will cost us about $25,000 because we have to do the systems engineering that wasn't done," he said. "As a result, we give the customer conceptional ideas even though he asked only for hardware."

The company is not apt to go overboard celebrating even if it wins the contract. "We also win a large degree of risk because we won't know how well the antenna will be put together, maintained or operated. Therefore who's to blame if it doesn't work?"

To cut down such risks, this missile/space company maintains field offices in several European locations. It also has about $1.5 million worth of specialized test equipment in Europe, together with technical personnel to take care of it. Another $1.5 million is put into spares.

These costs have to be recovered. Yet the company told how difficult it is to convince the Europeans of this fact. A European industrialist figures out how much a similar antenna will cost him to manufacture and feels the U.S. company is overcharging. This is one of several reasons the Europeans want to make the product for themselves.

This can bring about a licensing arrangement, which may satisfy everybody —after a breaking-in period.

- **Quality control differences**—The U.S. and Europe have several major differences in management philosophy, giving rise to problems. Many European industrialists, for instance, want perfection on their production lines.

A certain electronics product may require 20 operations before it becomes a subsystem. The U.S. company's quality-control method shows only four intermediate inspections are needed; this is the most economical way. But the licensee may inspect eight times along the way to get a higher quality product. Thus he will pick up errors earlier and get into arguments about poor control.

"What we find difficult to put across is that we'll find the error a little later in the game at a smaller unit cost," the U.S. sales manager said.

"We don't have this problem in either England or Japan," he continued. "There—if you'll pardon the expression—a licensee will make Chinese copies even if he has to buy duplicates of the machines we use."

Lack of systems management is another general condition in Europe. This is seen in the broadest programs as well as in the less ambitious ones. There is no systems manager for ELDO (the European space launcher program), for instance. Britain is building the first stage, France the second, Germany the third. Italy is making the satellite. "A prayer is binding the whole thing together," commented a U.S. engineer.

Europe, nevertheless, is learning. One of the fall-outs of the F-104 program is an appreciation of systems management, particularly in West Germany.

The U.S., however, cannot claim full credit for introducing the new management technique to Europe. Messerschmitt, for example, has been sending weapon-system teams all over Europe for a number of years. France gained considerable systems experience on her Mirage series of aircraft, as did England, with her P1 Lightning and TSR-2 reconnaissance aircraft. Still, systems management techniques are not widely practiced nor understood in Europe. Chief reason is that so few people have been involved in building the sophisticated systems requiring their use.

'Secret' NATO committee meeting.

The U.S. manufacturer should sell services as well as components and subsystems to the European market. He can also sell processes such as filament winding, or logistics support, which includes test equipment. The need for rapid readiness of defense equipment is a NATO theorem and calls for automatic checkout equipment at many sites—a natural market for American companies.

● **Legal considerations**—When it comes to setting up a legal association with a European company, the only full agreement among American representatives in Europe is that it's necessary—by licensing or some more permanent affiliation. Here are some notes from a conversation with the head of European operations for a U.S. company strong in electronics:

"The market as we knew it is no longer here. In some cases we are dealing with equals, in some cases superiors. In the electronics field, for instance, Europe is nearly on a par with us. Therefore to make sales in Europe, the best way is to cooperate in some way: a license agreement or a joint venture.

"If you have a unique product and a country needs it direly, you have a sale. Otherwise there is no chance unless you affiliate." He outlined the advantages:

—You can associate with a company already familiar with the government structure, which knows the personalities involved and can assure you of a favorable entree. Although the profit slice may be a little less, you're ahead because you don't have to pay for introductions or the salaries of many of the personnel involved.

—You can't do business in Italy without the right political connections; this makes the choice of the "right" company particularly compelling and profitable.

—Costs of proposals and research can be shared. Since the pay scales for European engineers and scientists are less than their American counterparts, this advantage should result in considerable savings.

—Unaffiliated companies stand a poor chance of winning a NATO competition. Thus if a combine of Dutch, Italian and Belgium firms are in a NATO competition against a U.S. firm, there is "no contest." One U.S. company was told outright to make its bid multi-nation.

● **Affiliation alternatives**—"We enthusiatically agree there is opportunity for business in Europe," said a representative from a large American R&D firm. "Even direct sales are possible in specific cases; for instance, Germany bought $126 million worth of Martin *Pershings*, and France is buying a Chance Vought plane.

"We feel that licensing is pretty much a dead end. We merely put the other company in business. A more permanent affiliation is necessary. We favor a joint subsidiary or stock trade stock purchase, especially in view of the common market situation."

He suggested that any manufacturing process unique to a U.S. company could lend itself to a joint subsidiary arrangement. "Take microminiaturization. If a European firm were deeply involved in electronics, we'd work out a deal so they'd supply the people and money, and we'd supply the technology."

Every person M/R spoke to agreed that the most difficult way is to build a plant in Europe and start producing there. France is already complaining about foreign interests moving in, setting up subsidiaries, and extracting profits for shipment home.

Beyond this is the management problem and its cost. The top executive of a U.S. affiliate must be an American if for no other reason than to keep the party line. He must be paid substantially more than he is paid at home because living in Europe is more expensive for an American than for a European.

His subordinates, though possibly Euporeans, will still expect to get compensation reasonably proportionate to their chief's. This expectation will follow all the way down the management line, with a consequent increase in overhead costs.

● **Security poses problems**—"Right now we can't talk to Europeans because of U.S. security policy," said a U.S. manufacturer in Europe. We can tell them how great our equipment is and that they ought to get some.

So they say: 'We're interested in guidance.' "

"Sorry!

" 'We're interested in propellants.'

"Sorry!

"We must get prior approval to discuss even unclassified material if it pertains to weapon systems. Under a recent ruling, we must give 45 days notice of a discussion of unclassified material, and 60 days for classified," the manufacturer said. He observed that this makes for lengthy conversations.

The law of Traffic in Arms is an outgrowth of the Nye Act put into effect after World War II. "It has a merchant of death atmosphere," said the manufacturer. "Scares you to death to read it. It needs modernizing for the space age."

His opinion was the most extreme of any M/R heard. The consensus was that the U.S. is making changes to help manufacturers of defense equipment, but slowly. A frequent complaint from U.S. representatives was that they should be able to talk to people in NATO about documents cleared to NATO—without first having to move a mountain of red tape.

U.S. manufacturers are quick to point up the Administration's endeavor for a favorable gold flow through American industry selling abroad; and the prohibitions thrown up to the missile/space industry by both the Defense Dept. and the State Department.

"Yet I'm damn glad Castro has no missiles," said a naval officer turned company representative. "And I'm glad Albania hasn't any and Ben Bella in Algeria and Nasser."

● **Company control**—A European company, in general, has far more to

How shall we advise Bonn?

say about a government contract it holds than a company in the U.S. does, where DOD and the military services have tremendous technical knowledge of their own. At the same time, only a few people in the government of a European country make technical decisions, which in the U.S. would require hundreds of people.

This condition is strongest in Germany, diluted in France, but present to a marked degree everywhere in Europe. It springs from political as well as economic grounds.

Despite a small technical staff, a European country can make intelligent technical decisions because ex-officio members of its staff comprise the country's industry. Thus European governments depend heavily on their industry for advice and decisions. Some quarters feel strongly that Germany's decision to build the F-104 was largely based on the recommendations of German industry.

The power of German industry, for example, was illustrated by an incident that took place at a get-together preceding the Third European Space Flight Symposium held in Stuttgart. An official of near ministerial rank, responsible for projects in the missile/space field, was asked about his country's future plans for R&D work.

He insisted that the query should be answered by Mr. Ludwig Boelkow—president of Boelkow-Entwicklungen K.G.—"who knows more about the subject than I do."

- **Political subcontracting**—What industry's strong position means is that government contracts are often given to particular companies on the advice of industry, and the subcontracting work distributed through political rather than competitive avenues. The significance of this to an American company trying to break into the pattern is evident.

To an American firm attempting to compete in Europe, it also can mean that it faces firms receiving major support from their government.

A recent example of this involved a large Dutch electronics firm. Certain requirements for military equipment were laid out at a NATO briefing. Through contacts cultivated over the years, a representative from a U.S. company was able to learn that such discussions had taken place. He was astounded when a representative of the Dutch firm seeking a job came to him the next day with a transcript of the minutes of the NATO meeting.

During a NATO committee meeting where unanimity is required before a contract is let, a certain non-French company was proposed as the supplier of spare parts for a weapon system it had developed. The only other company in the running as a supplier was a French company, but its lead time was higher, and so was its price. The French NATO representative, nevertheless, vetoed the developer of the system from getting the contract even though it meant letting critical equipment lie idle.

. . . and then there's security.

Some U.S. contractors are calling for similar help on the part of the U.S. government. These companies feel that they should get the same advantages and industrial intelligence. The only problem is in deciding which American company does the U.S. government help—even if it wanted to give such aid.

- **'Buy European' attitude**—There is no doubt in the minds of representatives of American industry that Europe will increasingly buy its defense and space material at home even if it means paying more. "Home" means "in Europe" because on defense buying the nationalistic spirit is breaking down—even in France.

A case in point is the Martin Co.'s experience with *Bullpup*, an air-to-surface missile already operational when on Oct. 26, 1961, the U.S. was persuaded to help France develop the *AS 30*—a direct competitor to *Bullpup*.

NATO, meanwhile, wanted to make a decision on a standardized ASM weapon but was stymied because unanimity was needed and France balked while she had the *AS 30* on the boards.

Today, both the *Bullpup* and the *AS 30* are being produced: the *Bullpup* will be in the U.S. military aid program with Britain, Norway and Turkey getting the weapon; while France will use the *AS 30* as will Britain and West Germany. Manufacturers of the *Bullpup* will be a consortium of companies from the using nations.

The NATO group is still trying to agree on a requirement for an ASM weapon, this time for one more advanced than *Bullpup*. Nord Aviation, Boelkow and the British Aircraft Corp. are now working on a proposal to NATO for such a weapon. In view of the countries they represent, they stand a good chance of winning the competition when it's announced.

- **U.S. parochialism**—The moral is that U.S. missile/space companies will more and more have to work with and through European companies if they want to do business on the continent. Many company executives in the U.S. unfortunately do not realize this.

Nor do they realize how much Europe has changed since World War II.

"We find a tremendous amount of parochialism at home," said one European representative. "My company is willing to take a gamble on the American market by making elaborate proposals and going into hock on company-funded studies, but when it comes to making a similar gamble in Europe, they want cash on the barrelhead."

"They forget that Europe is a booming economy," he said. "There's money here and a tremendous market."

But it's apparent U.S. industry will not be able to fully tap it until the new rules for doing business are learned. ■

. . . and a slice for your company.

Echo II Filled to Bursting To Gain Data on RF Reflectivity

LAKEHURST NAS, N.J.—Recent tests here of *Echo II* inflated spacecraft will provide a definitive correlation of optimum pressure vs. optimum rf reflectivity. Results of the experiments will be available this August and are expected to enhance success of the passive communications satellite due for launch later this year from the Pacific Missile Range.

Through repetitive pressure cycling from a relaxed condition (400-psi skin stress) to what proved to be a final bursting point of 11,200-psi skin stress, NASA officials hope to establish the temporal pressure which will rigidize a balloon surface sufficiently to provide optimal radio reflection over a long time period in orbit.

Echo project manager Herb Eaker, of Goddard Space Flight Center, stressed that the Lakehurst tests essentially represented an experiment, not a satellite test program in the normal sense.

Although the 135-ft.-dia. sphere duplicates the operational-type *Echo II* in its aluminum/mylar laminated structure, the vehicle used in the rf/pressure experiment was modified considerably to permit simulated orbital pressurization and pressure control. Four openings were made in the craft: one at each pole for pressure regulation; one air inlet and one air outlet with flow sleeves on opposite sides. Thus, Eaker pointed out, the openings created potential rupture points which would not be encountered in an operational craft.

The test program preparation, equipment installation and coordination of the entire effort was directed by Westinghouse Electric Corporation.

A major effort was to measure photogrammetrically the balloon contours (for degree of sphericity) over a planned series of inflation pressures. Army Map Service technicians performed the continuous data collection.

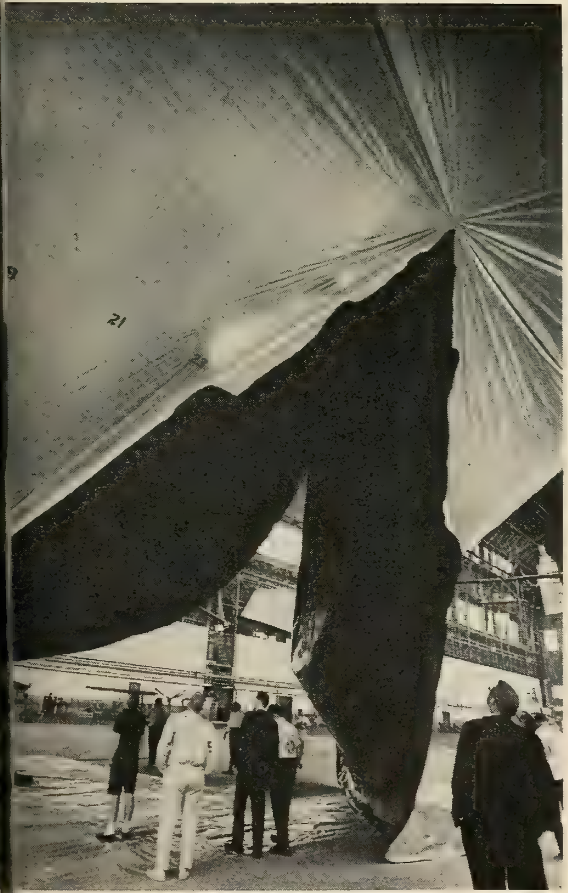
A second project task, performed by Conductron Corp., was designed to measure radio reflectivity as a function of bistable angle (over a 30°-arc horizontal track) and as a function of skin stress. Conductron will analyze rf data and correlate results with the photogrammetric measurements.

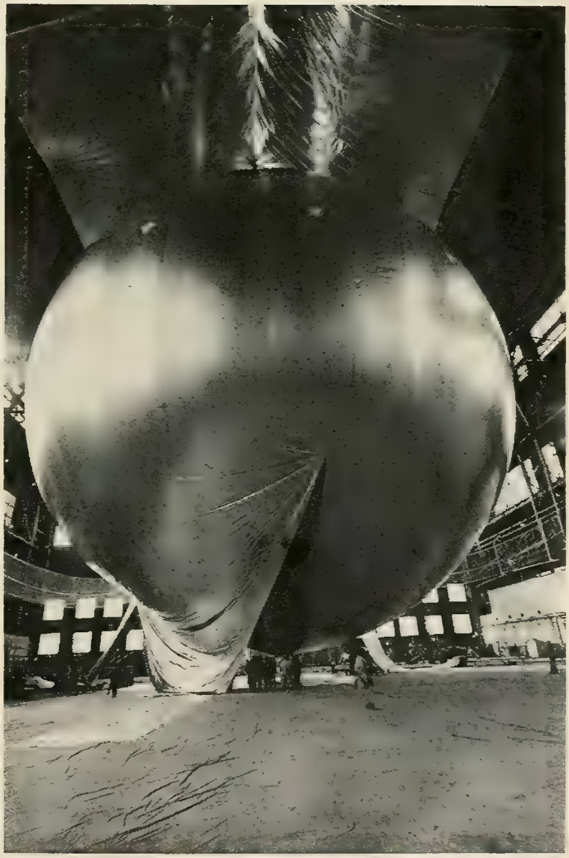
LEFT: *Echo II at start of 12-hr. inflation in Lakehurst NAS Hangar 1. Contour, photogrammetry, pressure and flutter test units are (from left to right) on scaffolding shown in background.* **ABOVE:** *Sphere reaching pressure level equal to 11,000 psi skin stress. Experiments were run at lower levels at constant pressures.*

BELOW: *Sphere bursts at south pole with pressure equivalent to about 11,200-psi skin stress. Originally designed for 4,000-psi skin stress, the 710-millionths-in.-thick satellite laminate had performed perfectly through a series of tests at various lower pressures, providing rf reflectivity data.*

BELOW: *Conductron engineers measure radio reflectivity using L- and C-Band radars. Both horizontal and vertical polarizations were employed and checks were conducted on the cross-polarized components.* **RIGHT:** *Westinghouse supplied the coordinating procedure and installed all equipment, including proximity displacement devices. It monitored pressure and timing and controlled tests through master console.*

BELOW: *Interior of the G. T. Schjeldahl Co.-fabricated sphere is coated with black ink to aid in heat stability. The 135-ft.-dia. sphere is constructed of 106 gores bonded together and then folded to fit the launch package. Artificial imposition of conditioned designed to obtain test objectives put sphere under stresses non-existent in orbit.*





ABOVE: *Echo II holds its shape despite jagged tear because of the laminates' stiffness.* **BELOW:** *Forlorn Echo graveyard in a corner of the hangar.*

Ambitious UTC Expansion Program Nearing Completion

Fast-paced construction schedule parallels burgeoning big solids work; Morgan Hill Development Center adds 27 buildings in year

by John F. Judge

COINCIDENT WITH the first full-scale firing of its five-segment, 250-ton *Titan III* booster—scheduled for July 20 by the United Aircraft Div.—United Technology Center is nearing completion of a multimillion dollar expansion program.

The building program barely kept pace with the firm's rapid rise in the large solid rocket field and various other areas in advanced solids, hybrids and liquid rocket technology. UTC has moved from a skeleton force of 300 employees in 1960 to over 2,300—the current personnel roster.

The headquarters buildings in Sunnyvale, Calif., and the sprawling 5,100-acre Development Center near Morgan Hill, Calif., have been expanded.

The Development Center alone grew by 27 new buildings in the past year and most of these are now operational.

UTC boosted its test firings from 300 in mid-1960 to over 3,000 in mid-1963, including some of the largest solid motors fired in the U.S. On the *Titan III-624A* program alone, the firm successfully fired two single-segment motors in the subscale tests leading to the full scale static firing.

While the 120-in. solid program absorbs about 50% of the firm's effort, UTC is actively researching a variety of propulsion areas. These include hybrids, high mass ratio solids for upper-stage applications, storable high-energy liquid-propellant engines and ablation-cooled upper-stage engines.

The research work goes deep into basic phenomena, with projects designed to probe combustion, ignition, detonation, thrust vector control principles, statistical thermodynamics at high temperatures and even non-chemical propulsion.

UTC's Sunnyvale Research and Engineering Center, 45 miles south of San Francisco, has four buildings containing more than 103,000 sq. ft. of floor area. They include:

- A two-story, 60,000-sq.-ft. administration and engineering building, which also houses executive offices, a technical library, and a cafeteria.
- A 13,200-sq.-ft. multi-purpose building containing an engineering laboratory, receiving and storage facilities, a machine shop, and warehouse space.
- An 18,000-sq.-ft. research laboratory equipped for physical and analytical chemistry studies and applied research on propellants, propulsion system components, combustion and materials. It has hydrostatic test cells, filament winding equipment, molding presses, tensile testing equipment, furnaces, and equipment to measure the burning properties of propellant.
- A 12,000-sq.-ft. development laboratory, where advanced high energy propellants, new propellant processing techniques, and new methods of component testing are developed. The building contains test cells for both solid and liquid propellants; facilities for oxidizer drying and grinding; equipment for propellant blending, mixing, casting and machining, and other operations. It also contains a data acquisition center.

In the present expansion program at Sunnyvale, a 48,000-sq.-ft. wing with special accommodations for a large computer and tabulating equipment has been added to the administration and engineering building. And a C-shaped 40,000-sq.-ft. extension is being added to the Research Laboratory.

- **Development Center**—Located 28 miles south of Sunnyvale, the Development Center has facilities for producing and testing the largest solid propellant rocket motors ever developed. Single solid propellant rocket segments containing up to 75 tons of propellant can be produced.

The Center is equipped with solid propellant processing and motor loading plants. There are test facilities for both solid and liquid propulsion systems, although about 80% of the land and facilities presently are devoted to solid propellant development. The Center has 79 buildings with six major additions to existing structures nearing completion.

The solid propellant test area includes four medium-sized test cells, each capable of testing motors of up to 250,000 lbs. thrust, and one large test bay that will handle motors generating up to 2 million lbs. of thrust. All test bays are completely instrumented, with data acquisition and test control functions conducted from a central contro room.

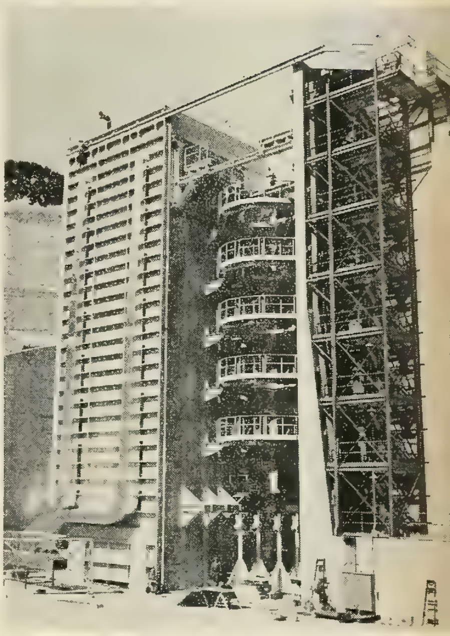
The largest test bay is capable of holding boosters developing up to 4 million lbs. thrust. This bay has a concrete thrust pad 20 ft. thick by 30 ft square, with buttress walls 95 ft. high—containing about 12,000 cubic yards of concrete.

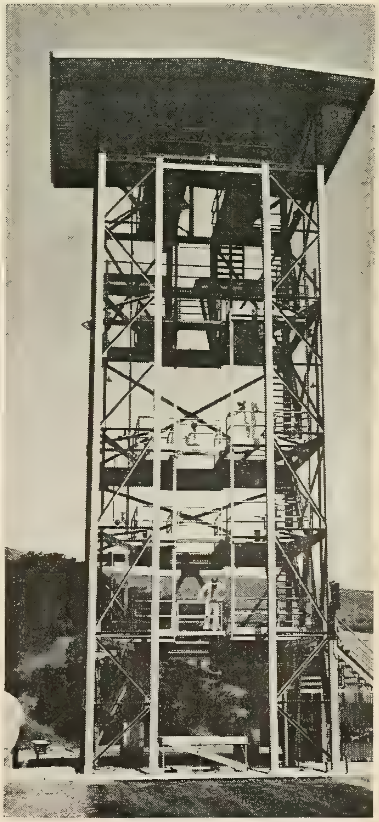
The vertical test bay is instrumented to perform more than 350 different rocket motor performance measurements, including thrust, pressure and vibration.

A new solid propellant mixer able to turn out more than 5,000 lbs. of propellant every few hours will soon be in operation. Other additions will include a 300-seat cafeteria, a hardware preparation facility and ingredient preparation laboratory, a small mixing station and propellant curing area, and a liquid thrust vector control complex.

- **Titan towers**—Two 65-ft. stee towers for testing the *Titan III* thrust vector control systems are in final stage of construction. The 34-ft.-long pressurized TVC tanks will be mounted in

RIGHT: A 200-ton crane is used to handle massive solid segments in test-firing areas. FAR RIGHT: Vertical test bay that holds the 250-ton, five-segment Titan III solid booster. BELOW: 50,000-lb.-thrust liquid test stand. BELOW RIGHT: Thrust vector control test tower used to check H. I. Thompson nozzles for first 120-in. firing.





the towers and the injection fluid fed through the system—with a test-tower maximum flow rate capability of 9,000 gallons per minute. The fluid is retained in catch tanks beneath the towers and returned to the system for re-use.

One cell will be in operation by the end of this month, the second is slated for use in September. Both can handle the *Titan III* TVC system in actual flight attitude.

A 200-ton capacity mobile crane is used to assemble the million-lb. rockets. The crane cab is equipped with closed circuit television that shows the operator the lift area when he is unable to see hand signals from the rigger. Produced by the Manitowoc Engineering Co., the unit was assembled at the UTC Development Center.

The massive crane will be broken down and shipped to Edwards Air Force Base in 1964—when static test firings of the *Titan III* boosters are scheduled.

Major buildings at the Development Center include a two-story plant administration and engineering building, a receiving and inspection building, and a hardware preparation building.

A large number of solid propellant preparation, processing and mix stations are scattered throughout the remote valleys of the Center.

● **Curing ovens**—Propellant castng, curing and trimming facilities include one of the largest in-ground curng ovens ever constructed. Solid propellant motors up to 20 ft. in diameter, 35 ft. long, and containing 150,000 bs. of propellant can be cast and cured n the huge oven, more than 20 ft. across and 40 ft. deep.

The big oven is equipped with heatng and cooling systems and vacuum and nitrogen pressurizing systems. For processing solid motors of up to 120 in. in diameter and 22 ft. long, two large, fully equipped in-ground ovens are used. ■

Gemini Digital Command System Readied by Radiation, Inc.

First unit going to Atlantic Missile Range in fall; highly flexible device may be used in Apollo role

by Michael Getler

MELBOURNE, FLA.—The first production unit of the highly flexible Digital Command System (DCS) to be used in *Project Gemini* will be delivered to NASA at Cape Canaveral in September.

Radiation Inc. will deliver nine units to the space agency under terms of a $2.5-million contract from NASA's Goddard Space Flight Center. Seven of the systems will go to sites in NASA's global manned spacecraft tracking network, including one shipboard installation, and two will go to Wallops Island for training purposes.

If performance levels are met, the DCS program is thought to have considerable potential through *Gemini* and into *Project Apollo,* in both the extension of equipment capabilities and the number of units.

Observers estimate that production could be increased to at least 15 complete systems to meet added requirements for the Integrated Mission Control Center at Houston for latter phases of *Gemini* and then *Apollo,* possible increased shipboard use, and for proposed new tracking sites in support of *Apollo.*

Development of the DCS will give NASA a vastly improved command system capability in comparison with the limited go/no-go tone-control system used in *Project Mercury.*

DCS will receive, store, and transmit real-time and programmed command data to both the manned *Gemini* capsule and the unmanned *Agena* rendezvous vehicle. In addition to command data, the system handles transmission of velocimeter and several clock-time functions to correct or up-date on-board counters. It will also be configured as a back-up boost phase guidance link.

● **Multiple paths**—The DCS is designed for redundant transmission paths, plus multiple parity and validity checks on all data to insure accurate transmittal and receipt. There are three basic data ground checks before transmission, plus a fourth in the flight loop, engineers here report.

Several modes of transmission are available, and the entire memory contents of the Cape Canaveral DCS can be fed to distant units via a teletype link.

The NASA communication network will allow control over the DCS at the Atlantic Missile Range and, in turn, at all other locations, by the Goddard computer facility. This allows Goddard to execute a rapid change of the entire DCS program memory based on new data inputs.

Engineers here have used a functional modular packaging concept on DCS, which has reportedly met with wide acceptance within NASA because of relatively easy access to modules, test points, and system wiring in a system which, in its current configuration, uses about 12,000 solid-state plug-in rectangular modules.

Component interconnections within these modules are welded, and then the assembly is transfer-molded in epoxy. Interconnections between modules are made using wire-wrap techniques in almost all cases, except a small number of vendor-supplied printed cards in the memory. These are soldered.

Radiation engineers told MISSILES AND ROCKETS that the firm now has under development an automated wire-wrap system which may be applicable to DCS shortly after the current production units are completed.

Completed modules mate with panel-mounted Malco connectors, forming a casting that serves as a vertical slide mounting. It holds about 800 modules and fits standard cabinets.

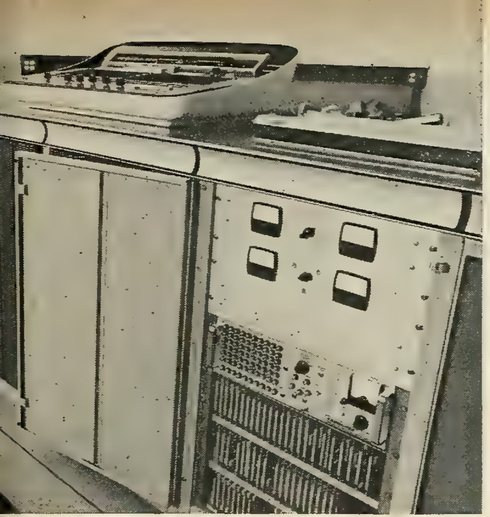
The DCS non-destructive core memory system can store 512 40-bit valid command words. For *Gemini,* however, engineers say the memory will be set up to handle only 364 command words. This figure, they report, still considerably exceed the *Gemini* command requirements now said to be fairly firm within NASA.

● **Expandable memory/data rate**—The memory reported can be easily expanded to 1024 60-bit words for *Apollo* programs that may be considerably more complex than *Gemini* digital command requirements. Also, the DCS 200-cps data bit-rate for *Gemini* can be increased to 100 kc, Radiation reports, to meet increased data needs at higher rates anticipated for *Apollo.*

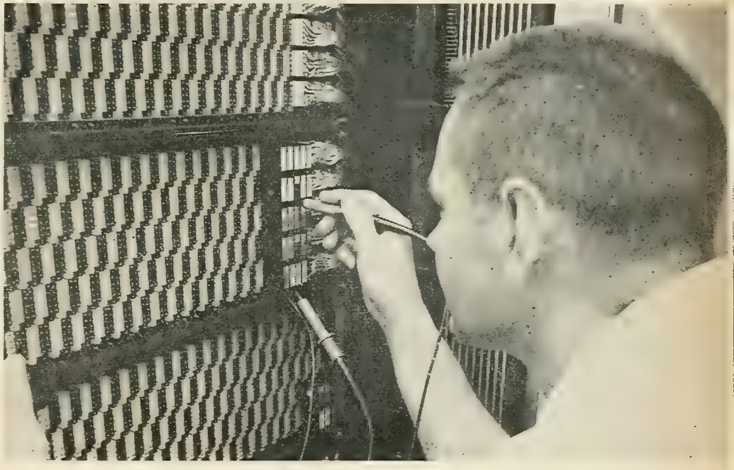
The basic 364-word DCS memory is divided between the *Gemini* and *Agena* vehicles. Essentially, "computer words," representing large programs stored in the DCS memory, will be transmitted to the *Gemini* on-board computer with stored-program data going to the *Agena* on-board memory. Real-time commands will go to both vehicles.

The first 32 words in the memory section for each vehicle are designated as priority words, with the next 150 command words in each rounding out the available program storage.

The DCS memory can be loaded through several paths. Incoming teletype or high-speed Bell-201 data are inserted serially and are accompanied by parity checking bits. On-site NASA computer inputs, and inputs from the J-1 ground-guidance computer at Cape



FIRST DCS CONSOLE, (left) nearing completion at Radiation, Inc., will go to NASA at Cape Canaveral in September. Uncovered portion at right in photo is power supply section.



TECHNICIAN CHECKS logic circuitry (right) mounted aboard DCS sliding panels. Packaging of unit allows sy access to most of the 12,000 solid-state plug-in modules.

Canaveral are inserted in parallel (the Cape DCS is the only one that can handle the J-1 link).

Manual inputs can be inserted directly into the DCS input/output buffer. A switching control allows selection of any input path, interlocking all others.

Use of DCS as a backup boost phase guidance link is accomplished by adding a communications link between the on-site J-1 ground-guidance computer, which communicates directly with the booster guidance, and the DCS.

If the computer-booster path fails in flight, the computer can then use the DCS link to the capsule, with an additional "black box" required to link the booster and payload. Subsystems needed to build this into DCS are expected to be completed before delivery of the first unit.

• **Transmission modes** — Three modes of transmission are available to the DCS operator: automatic sequential, which allows transmission of the entire memory contents; automatic select, which is basically the same except that only certain selected words are transmitted; and manual, where a single word, either inserted manually or from the memory, is transmitted.

Any of these modes, Radiation engineers report, may be interrupted by an emergency override that allows one to 32 priority words from each vehicle's memory storage to be transmitted. DCS automatically resumes transmission at the last point in the original mode after priority interrupt.

DCS will use the Collins Radio Co.'s AN/FRW-2 transmitter and existing telemetry antenna facilities at the trackng sites.

Engineers here point to several feaures that enhance data link reliability. A sub-bit coding technique is used, enabling the capsule to recognize when up-link bit errors have occurred. Each data bit, Radiation reports, is coded by a unique five-bit pattern so that any deviation from this pattern is recognized as an error, with the PCM down-link used to transmit a valid or non-valid return signal for each word transmitted from the ground.

There is also extensive duplication and self-checking circuitry in the ground equipment. According to Radiation, there are two independent data paths from the DCS memory to the transmitting antenna. Each subsystem in each path contains an error detector.

An automatic path-selection and switching capability, having inputs from the individual error detectors, is provided at the antenna end of the two paths, and also at the approximate midpoints. Consequently, an operating data-transmission path can be selected for any single subsystem failure, and for many multiple subsystem failures.

Additionally, engineers point to an operator re-transmit control that allows automatic transmission of each word containing an error detected anywhere in the loop. Each word can be repeated seven times.

In addition to the system self-checks, there is a manual display capability for the operator to call up and observe each command word before transmission.

• **Controller interface**—The DCS console with complete display, storage, and transmission capability is classed as "back-room" equipment, meaning that it is physically apart from that portion of *Gemini* control where actual flight control is done.

To take full advantage of DCS capabilities and relieve the burden of complexity on *Gemini* flight controllers, NASA ordered changes in the basic DCS data system, allowing it to be tied into a greatly simplified "front-room" flight controller's console. These front-room consoles are being built for NASA by the Bendix-Pacific Div., Bendix Corp.

Bendix, under a $3-million NASA contract, will supply five consoles for each DCS site, plus an extensive amount of interface cabling. First console breadboard models were recently shown to NASA.

Engineers here say that current plans call for setting up flight control consoles with 90 key DCS-remote real-time command buttons, roughly divided between *Gemini, Agena,* and CapCom (capsule communicator) consoles.

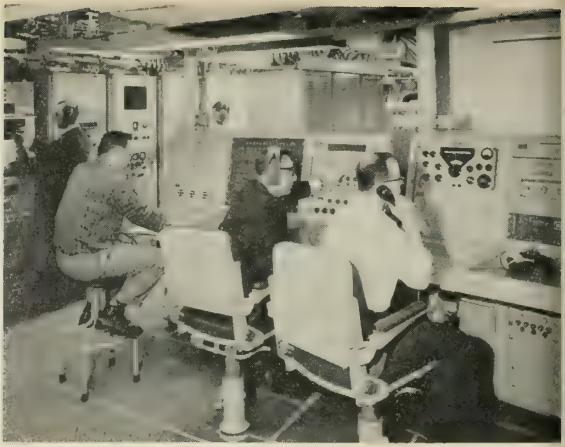
A one- to two-man flight-surgeon console will also be included, as will be a maintenance and operations console, which will monitor the status of all sight instrumentation and antenna positions.

Additionally, controllers will have single *Agena*-load and *Gemini*-load buttons which will allow transmission of an entire program, and three clock buttons (time-to-function, time-to-equipment-reset, and time-to-retro-fire).

Controllers will also have mode-selection capability with interlocks to insure against dual control of mode. In the event of front-room failure, the mission could be controlled from the main DCS console.

Radiation engineers report roughly 25-30 additional logic units are required to back up each command controlled from the front consoles. This basically allows a controller to push a single button to get action on a command that would normally require five or six operations from the DCS console. ■

THIRTY-FOOT TELEMETRY antenna being installed atop the Vandenberg. Antennas (left to right): C-band, L-band/UHF, telemetry, and meteorological (in radome).



COMMUNICATIONS CENTRAL will link the ARIS ship with Cape Canaveral by voice, teleprinter, and high speed data communications.

space electronics

Air Force Dedicates Second ARIS

USAFS Vandenberg to track Polaris and manned spacecraft from Indian Ocean

by Charles D. LaFond

BAYONNE, N.J.—The USAFS Gen. Hoyt Vandenberg, second of two Advanced Range Instrumentation Ships, was scheduled for completion here last week and formal dedication at Baltimore July 18.

Late Friday, following an inspection and tour by DOD and congressional officials, the highly instrumented tracking vessel was due for departure to Cape Canaveral and an early three-month shakedown cruise in the Atlantic off Grand Bahama Island.

The Gen. Vandenberg, with its sister ship the Gen. H. H. Arnold (dedicated May 1), ultimately will operate in the Indian Ocean. Both are converted 14,300-ton World War II troop transports.

The total conversion to modern tracking stations—among the most highly instrumented in the world—was directed for the Air Force by Sperry Rand Corporation. Initially a $50-million contract awarded by the AF Missile Test Center, Patrick AFB, Fla., in July, 1961, the funding at present exceeds $130 million.

The two vessels carry essentially the same electronic subsystems with one notable exception. The Gen. Vandenberg will be provided within one year with a UHF radar instead of the X-band provided on the Gen. Arnold. A $5-million-plus contract for development of the new system was awarded to Sperry early in June.

The original need for the program was based on a support requirement for ABRES (Advanced Ballistic Re-entry Studies). Very broad use, however, is now contemplated for the floating tracking stations. Besides support for the *Polaris A-3* development program, the ships also will be employed in the manned spacecraft program. For the latter, it is expected that S-band radars eventually will have to be installed aboard the vessels.

ARIS Team Contractors

Sperry Rand Corp.

Prime contractor plus mfr. of SINS, Data Processing System, Operations Control Center, Parametric Amplifiers, Servo Units

Bethlehem Steel Co.

Ship reactivation and conversion.

Gibbs & Cox, Inc.

Marine architecture and ship conversion supervision.

ITT Federal Laboratories

Telemetry, radar video, internal and external communications, timing system, meteorological system.

- **200-man station**—A total complement of 200 (including a 90-man crew supplied by Marine Transport Lines) will be required to operate the Gen. Vandenberg and its maze of electronic equipment.

Radio Corporation of America will provide roughly 90 technicians and Pan American World Airways will be responsible for directing operation of the station. Pan Am's Fred Sponholz will direct tracking operations; D. L. Ely of RCA will direct the technical crew and be responsible for the instrumentation. The ship's master is Captain Mark Twain Wheeler.

Both ARIS-1 and -2 will be capable of up to 60 days continuous operation at sea.

- **Principal subsystems**—Primary tracker is a C-band (5400-5900 mc) radar employing a 30-ft. dish and three parametric amplifiers. The latter are liquid nitrogen cooled. (The ship generates its own liquid nitrogen at 6-8 liters/hour. Boil-off from this abundant supply provides the pressure necessary to pump coolant to a Dewar on the antenna mount.) The radar provides an average power output of 4.8 kw, and 1-megawatt peak.

A 40-ft. dish will be employed for both the L-band and the future UHF radar systems. The former provides a 48-kw average power with a 10-mw peak output. It is provided with two uncooled parametric amplifiers. (The UHF system will be rated at 60 kw av. power, 12 mw peak, and have one uncooled paramp.)

A Sperry Mk-1 SINS (Ships Inertial Navigation System), coupled with a star tracker, will provide a stable reference. A collimated-beam light tunnel couples the platform to the C-band radar antenna mount. A flexure-monitor system senses and measures mount deflections up to 4 minutes of arc and records the data. Following a tracking mission these data, with similar outputs for the L-band/UHF antenna, can be employed for correcting back to the SINS output through a Univac 1206 computer.

The same system can be used in closed-loop for a real-time calibration mode.

A very broadband telemetry system is provided for greater flexibility. Its 30-ft. dish and unique feed offers a 215 to 1000-mc tracking capability combined with a 12.5 to 14.5-gc Cassegrain vertex feed for re-entry acquisition and telemetry reception. Also, its capability could be extended to 23,000-mc range.

Key to such operational versatility is a 700-lb., dual-conical Log-periodic feed. Scanning at 1200 rpm, the feed provides simultaneous left-right polarization.

Each of the three large antennas is supported by an 85-ton precision pedestal and mount. Each employs temperature-controlled pre-loading for the pedestal main-support bearing to reduce friction and improve operating smoothness. Elevation coverage is −15 to +95 degrees at over 25 degrees/sec.; azimuth coverage is 305 degrees at more than 35 degrees/sec.

External communications are provided through three long-range (up to 10,000 miles) radio systems for voice, teleprinter, and high-speed data. A 10-kw transmitter is used for MF and HF communications, and two 2.5-kw transmitters provide wideband communications in the HF, VHF, and UHF anges. Helical mast antennas cover he 15 kc-400 mc range for transmit-eceive and for reception only at VLF.

A timing system using both WWV for HF) and WWVL (for VLF) can be synchronized to Cape Canaveral time o within 0.01 sec. The system, according to Sperry, is stable to within 5 parts in 10 billion per day.

Weather profiles to 250,000 ft. will e obtained using wiresonde/balloon nd *Arcas* sounding rockets launched from the fan tail. ■

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IN BOEING'S SEATTLE Minuteman control room presentation area, audio-visual personnel keep schedules up to date.

management

Challenge Met in Minuteman Management

by Robert Twiss

WEAPON-SYSTEM MANAGEMENT, growing in complexity with the systems themselves, is an increasingly important "product" of the aerospace industry.

Major programs, such as the Air Force *Minuteman* intercontinental ballistic missile, pose staggering management challenges not only to the military but the major contractors involved.

The *Minuteman* management job has been demanding ever since the system left the drawing board, for the tight timetable called for war-ready missiles in their launching silos in less than four years.

The Boeing Co., weapon-system integrator for *Minuteman,* developed a control center at the firm's Seattle Developmental Center to keep track of every phase of the project—the airborne vehicle itself, bases, ground support equipment, schedules and so on.

• **Situation at a glance**—Thus, when Air Force officials call at Boeing to review program progress, they are taken to the two high-security control rooms, where flip charts contain up-to-the-minute progress reports.

These "nerve centers" of the *Minuteman* program are classified as either presentational or operational. The presentation area contains the *Minuteman* master schedule and cost control information.

The operational area, through the use of visual aids, offers a quick picture of the never-ending battle of keeping production achievements abreast with scheduled objectives.

Smaller replicas of the centers are situated at each *Minuteman* base, with each base center keeping in constant touch with the Seattle operation.

The greatest bottleneck in the *Minuteman* program—as in any major weapon system project today—is communications—keeping everybody involved informed of developments in various areas, changes of plans and similar information.

• **Born of necessity**—The *Minuteman* Management Control System came about because modern weapon systems have become so elaborate and sophisticated that it is difficult to keep up with their complex development and production. Management requires vast stores of information, kept current and at its fingertips, to direct operations toward meeting schedules.

A plan based on this philosophy was created for the *Minuteman* program in late 1960, and it became a reality the next year. Through evolution and refinement, the present center was established.

• **From the horse's mouth**—Each base control room is self-sufficient in portraying its own program status against master schedules, plus detailed working plans for its local operations. The program manager at each base has his finger on the pulse of his organization's performance and costs. This day-to-day progress is transmitted to the Seattle MCC, where it appears in graphic, visual-aid form permitting a quick picture of each base's advancement toward *Minuteman* customer delivery objectives.

Along with each remote base's operational progress, the MCC contains the over-all *Minuteman* weapon system programming and planning schedules in summary form.

Supporting this summary programming is each participating organization's current status-versus-achievements.

These organizations include contract administration, engineering, manufacturing, material, service engineering, remote operations, facilities and finance. Information from agencies and associate contractors in the key solid-fueled missile program also is collected.

By means of these control devices Boeing *Minuteman* management is able to review rapidly the day-to-day progress of the project, accurately identify potential and actual problems and issue scheduling direction. A problem-resolution system is a major control.

• **Stitch in time**—One great advantage of such a system is its ability to spot problem trends before they reach a point where costly, time-consuming fixes are required.

Minuteman branch management, as well as organizational management, also can hold briefings and make presentations of any portion of the program through use of the control devices and audio-visual aids in the center. Customer meetings and presentations are a large order of business in the control rooms.

The speed needed to develop and deploy the rapid-firing *Minuteman* missiles—the program is committed to the most compressed time scale ever scheduled for development of a major weapon system—accounts for the need for streamlined management.

The Boeing B-52 eight-jet bomber, the nation's principal manned deterrent retaliatory weapon, took about ten years to go through the same cycle *Minuteman* completed in less than four years.

Future systems undoubtedly will also face compressed development schedules, to cope with the various threats around the world. Hence management must continue to devise ways to keep pace with weapon-system development requirements. ■

New Firms and Divisions

Philco Corp.'s Computer Div. has been consolidated with its Communications & Electronics Div. in a step toward increased depth in total systems capability. A new business area, Information Systems, has also been added to C&E to integrate Philco's computer capabilities with its experience in command and control and communications systems. . . . *Electro Instruments, Inc., San Diego, Calif., electronics firm, has formed an independent sales company, Electro Instruments Sales. EI Sales will handle accounts of other electronics firms, in addition to those of the parent firm. Headquarters of the new company will be in San Diego, but it will operate through 24 regional offices throughout the U.S.* . . . International Telephone and Telegraph Corp. has consolidated its U.S. Defense and Space Group field marketing offices into one organization. The new organization is to represent the entire capabilities of 11 ITT units to the government and military markets. Formerly each of the 11 units had its own field marketing and sales representatives. Group headquarters will be in Nutley, N.J., with regional offices in Washington, D.C., Dallas, and Santa Monica, Calif. . . . *General Kinetics, Inc., Arlington, Va., has added a quality control department to perform in-process and final testing of its line of magnetic tape testers, winders, cleaners and erasers.*

Mergers and Acquisitions

Amphenol-Borg Electronics Corp., Broadview, Ill., has purchased the coaxial switch business—exclusive of liabilities—of General Communications Co., Boston, an Atlantic Research Corp. subsidiary. The business is to become part of Amphenol's FXR Div. and is to be moved to Danbury, Conn. . . . *Northwest Industries, Inc., Portland, Ore., has acquired Product Engineering Co., also of Portland. Product Engineering is the largest die casting firm in the Pacific Northwest, and NWI is a metals firm specializing in refractory, reactive and corrosion-resistant metals machining and fabrication for missile/space and chemical industry use.* . . . Globe Industries, Inc., Dayton, Ohio, manufacturer of precision electric motors, has contracted to purchase rights to McGraw-Edison Co.'s precision rotating components, manufactured by that firm's Instrument Div. in West Orange, N.J. Purchase is to include all engineering and other technical data, parts inventory, tools, dies, gages, fixtures, test equipment and other material involved in the manufacture and sale of the components. The precision rotating components line consists of motors, tachometer generators and gear reducers. . . . *Philmont Pressed Steel, Inc., Huntington Valley, Pa., has purchased Kamis Engineering Co. of Philadelphia. Kamis will become a subsidiary of Philmont and will continue precision machining of metal parts for the missile/space and aircraft industries. In the past, Philmont has manufactured auto accessories, general hardware and garden equipment.* . . . Visual Industrial Products, Inc., Oakmont, Pa., has bought the name, copyrights, equipment and inventory of Visual Plant Layouts, Inc., also of Oakmont. VPL manufactures scale models for sales, engineering design, plant and office layouts, architectural and other model applications.

Industry Facilities

Sanborn Co., a subsidiary of the Hewlett-Packard Co., Palo Alto, Calif., has opened a new $2-million plant one mile from its Waltham, Mass., headquarters. The plant will serve the firm's Transducer Div. as a manufacturing, engineering and sales facility for transducers with military, industrial and medical applications.

Company Representatives

Burlingame Associates, Mount Vernon, N.Y., has been named field engineering representative for Vitro Electronics Div. of the Vitro Corp. of America in the northeastern U.S. FE, headquartered in Silver Spring, Md., supplies custom telemetry, surveillance and communications electronics for missile/space applications under the Nems-Clark brand. . . . *Hollywood Radio and Electronics, Inc., Hollywood, Calif., has been appointed San Diego-Los Angeles-Santa Barbara area industrial distributor for Siliconix, Inc., Sunnyvale, Calif., manufacturer of semiconductor components and integrated circuits.* . . . James L. Highsmith & Co., Huntsville, Ala., Orlando, Fla., and Charlotte, N.C., has been named southeastern States representative for Research-Cottrell, Inc.'s Electronics Div. R-C manufactures d-c power supplies, transformers, control systems, and related systems for military, industrial and research applications requiring high-voltage, high-frequency d-c power. . . . *Robert M. McDonald, 744 Broad St., Newark, N.J., has been named North Jersey technical and sales representative for the Durilith Corp., Philadelphia electronics firm.* . . . Biechler Associates, Baltimore, has been appointed to represent Industrial Electronic Engineers, Inc., in eastern Pennsylvania, southern New Jersey, Maryland, Virginia and Washington, D.C. IEE, North Hollywood, Calif., offers a line of rear projection binary to decimal, cue-switch, analog to decimal, and status indicator readouts, and electro-mechanical decoders. . . . *Poly-onics, Inc., Leawood, Kans., and St. Louis, Mo., has been appointed Dana Laboratories representative for Nebraska, Missouri, Kansas and western Illinois. Dana manufactures digital voltmeters and d-c differential data amplifiers.*

AWARDS

AIR FORCE

$7,095,250—**Vitro Corp. of America, Vitro Services Div.**, Eglin Air Force Base, Fla., for management and operation of the Air Proving Ground Center land range test areas and the Eglin Gulf Test Range, Fla.

$4,100,000—**FMC Corp.**, Baltimore, Md., for production of propellants.

$3,502,000—**Beckman Instruments, Inc.**, Fullerton, Calif., for ground based telemetry systems to process data from missile and space flights supported by the Atlantic Missile Range (two contracts).

$1,937,134—**Beckman Instruments, Inc.**, Fullerton, Calif., for time measuring instruments for the Atlantic Missile Range.

$1,900,000—**General Dynamics Corp.**, Astronautics Div., San Diego, Calif., for fabrication of space boosters.

$1,900,000—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., for reinforced grain solid rocket motor.

$1,200,000—**Radiation, Inc.**, Melbourne, Fla., for pulse code modulation telemeters for *Titan III* missile program.

$1,000,000—**Goodyear Tire & Rubber Co., Goodyear Aerospace Corp. Div.**, Akron, Ohio, for a study of deceleration and stabilization systems for advanced re-entry vehicles.

$1,000,000—**Emerson Electric Mfg. Co., Electronics and Space Div.**, St. Louis, Mo., for development of a checkout system for maintenance programs.

$830,000—**Eitel-McCullough, Inc.**, San Carlos, Calif., for development of a traveling-wave tube amplifier.

$745,000—**Dynalectron Corp., Stepper Motors Div.**, Gardena, Calif., for additional production of ALE-20 infrared countermeasures devices used to protect manned aircraft from heat-sensing missiles. (Awarded jointly with the Boeing Co.)

$494,650—**Sylvania Electric Products, Inc.**, Waltham, Mass.; for study and design of HF and UHF antennas capable of withstanding exposure to blasts from nuclear weapons.

$487,821—**Amcel Propulsion Co.**, Asheville, N.C., for applied research for a controllable solid propellant rocket motor.

$396,017—**Lockheed Propulsion Co.**, Redlands, Calif., for applied research for development of a hi-energy solid propellant.

$360,000—**General Electric Co., Missiles and Space Vehicles Div.**, Philadelphia, for a study of propellant storability in space.

$317,557—**Thiokol Chemical Corp., Reaction Motors Div.**, Denville, N.J., for a study of thrust chamber assembly and turbopump for gelled propellants containing suspended solids.

$202,708—**Hercules Powder Co.**, Wilmington, Del., for development of high energy solid propellants.

$173,542—**Curtiss-Wright Corp., Wright Aeronautical Div.**, Wood-Ridge, N.J., for research and development, fabrication and delivery of three rocket engine nozzles.

$140,000—**General Motors Corp., AC Spark Plug Div.**, Milwaukee, Wis., for replacement parts for TM76B *Mace* missile weapons system.

$135,488—**Aerojet-General Corp.**, Azusa, Calif., for space environment studies.

$125,000—**Space Technology Laboratories**, Redondo Beach, Calif., for design, fabrication and test of new concepts for a propellant feed system.

$117,121—**Aerojet-General Corp.**, Sacramento, Calif., for applied research and development, fabrication and delivery of non-regeneratively cooled rocket engine thrust chambers and nozzles.

$112,241—**North American Aviation, Inc.**, Canoga Park, Calif., for demonstration of high performance of a light-weight thrust chamber assembly using high-energy storable propellant combination.

$100,000—**Martin Co., Nuclear Div.**, Baltimore, Md., for development of a new kind of direct energy conversion device which may be used with nuclear reactors in space.

$100,000—**FMC Corp., Ordnance Div.**, San Jose, Calif., for a feasibility study of a transport and handling system for large solid rocket motors.

$100,000—**Atlantic Research Corp.**, Alexandria, Va., for advanced propellant upper stage motor development.

$70,000—**A. D. Little, Inc.**, Cambridge, Mass., for research on hi-temp metal fibrous materials.

$54,106—**The Franklin Institute of Pennsylvania**, Philadelphia, for research on beryllium distillation by sublimation and evaporation.

$45,894—**Alloyd Electronics Corp.**, Cambridge, Mass., for research on distillation of beryllium.

$37,453—**Marquardt Corp.**, Van Nuys, Calif., for spare parts applicable to IM-99 *Bomarc* missile.

$29,822—**Space General Corp.**, El Monte, Calif., for development of a preliminary design of an *Aerobee* sounding rocket of improved burnout attitude.

$7,584—**Project Designs, Inc.**, Hicksville, L.I., N.Y., for technical data in support of IM-99B *Bomarc* missile.

ARMY

$15,000,000—**General Dynamics Corp.**, Pomona, Calif., for continued research and development on the *Mauler* weapon system.

$14,000,000—**International Telephone and Telegraph Corp., Federal Laboratories Div.**, Nutley, N.J., for work on a European communications system.

$6,400,000—**Raytheon Co.**, Andover, Mass., for high power illuminator radar sets for the *Hawk* missile system.

$5,787,436—**Hercules Powder Co.**, Wilmington, Del., for manufacture of missile propellants.

$5,700,000—**Bogue Electric Manufacturing Co.**, Paterson, N.J. for an advanced type of motor generator set.

$2,500,000—**Radio Corp. of America**, Philadelphia, for continued performance leading to the development of Multisystem Test Equipment (MTE) for various missile systems.

$2,434,010—**Universal Moulded Fiber Glass Corp.**, Bristol, Va., for shipping containers for the *M-44* rocket.

$2,200,000—**Carpenter Brothers**, Dallas, for support area facilities at NASA's Mississippi Test Operations Center.

$2,000,000—**International Business Machine Corp.**, Washington, D.C., for electronics equipment.

$2,000,000—**General Telephone & Electronics Corp., Sylvania Electronics Products, Inc.**, subsidiary, New York City, for electronics equipment.

$1,700,000—**Raytheon Co.**, Andover, Mass., for parts and components for the support of the NATO "D" production run of the *Hawk* missile system.

$1,700,000—**Martin Marietta Corp.**, Orlando, Fla., for components, spare parts, modifications and reconditioning of *Pershing* missile system (eight contracts).

$1,000,000—**Northrop Corp., Ventura Div.**, Newbury Park, Calif., for continuation of services of target air launch, flight control, tracing and maintenance in the Far East of the *CP-76* rocket-powered target drone.

$1,000,000—**Raytheon Co.**, Andover, Mass., for ground equipment for the *Hawk* missile system.

$725,000—**Dynaelectron Corp., Land-Air Div.**, Holloman Air Force Base, N.M., for continuation of research and development work in electronic and range instrumentation at the White Sands-Holloman Missile Range.

$711,420—**Raytheon Co.**, Andover, Mass., for field maintenance engineering services on the *Hawk* missile system.

$574,953—**Raytheon Co.**, Andover, Mass., for maintenance equipment for the *Hawk* missile system.

$341,842—**Avco-Everett Research Laboratory**, Everett, Mass., for research in re-entry physics

$309,000—**Hayes International Corp.**, Birmingham, Ala., for *Pershing* missile system traine concurrent spare parts.

$262,807—**Paul Hardeman, Inc.**, for part four o the contract to construct space environmen simulation chambers at the Manned Spacecraf Center, Houston.

$192,600—**Douglas Aircraft Co.**, Charlotte, N.C. for acquisition of facilities required to sustai base production unit for *Nike-Hercules* missile system.

$135,750—**The Lummus Co.**, for design of vibration test laboratory for the launch environment and antenna test facility, spacecraft control technology labs of the Manned Spacecraft Center, Houston.

$110,498—**Litton Industries, Inc.**, San Carlos Calif., for design, development and fabrication of an experimental model of an in-flight space scanner.

$95,400—**Western Electric Co.**, New York City for parts for the *Nike-Hercules* missile.

$81,000—**Mellonics Systems Development, Inc.** Sunnyvale, Calif., for a satellite communications tracking study.

$74,024—**Brown Engineering Co.**, Huntsville, Ala. for engineering analysis of missile intelligence data.

$25,400—**Tool Industries of Florida, Inc.**, New York City, for repair parts for guidance/control unit of *Pershing* missile shipping and storage containers.

NAVY

$5,484,000—**Westinghouse Electric Corp.**, Pittsburgh, for design of a nuclear reactor and for production of tubes for the *Typhon* surface-to-air missile system at Elmira, N.Y.

$1,900,000—**Westinghouse Electric Corp., Plant Apparatus Div.**, Pittsburgh, for components for fleet ballistic missile maintenance training facilities.

$1,100,000—**Aeronca Mfg. Co.**, Middletown, Ohio for a large tracking antenna system.

$1,100,000—**Dynaelectron Corp., Paradyn Div.** Point Mugu, Calif., for continuation of data reduction, programming and mathematica services at the Pacific Missile Range.

$249,000—**Reflectone Electronics, Inc.**, Stamford Conn., for design and development of the *Sheridan/Shillelagh* weapon system trainer for the Navy's Training Device Center, Por Washington, N.Y.

NASA

$36,200,000—**International Business Machine Corp.**, New York City, for installation o computers to monitor future *Apollo* and *Gemini* space flights at the Manned Spacecraft Center, Houston.

$11,708,225—**Mason & Hanger-Silas Mason Co.** and **Rust Engineering Co., Mason-Rust unit** New Orleans, La., for support services at the *Saturn* booster plant.

$3,555,000—**Lear Siegler, Inc., Electronic Instrumentation Div.**, Anaheim, Calif., for design and fabrication of data acquisition systems a the Marshall Space Flight Center, Huntsville Ala.

$3,200,000—**USAF Space Systems Div.**, for funding the *Agena* modification for the *Gemin* program.

3,000,000—**ACF Industries, Inc., ACF Electronics Div.,** Paramus, N.J., for provision of radar beacons for Project *Apollo.*

1,271,662—**Electronic Communications, Inc.,** St. Petersburg, Fla., for flight control and switching devices for use in the *Saturn* program at the Marshall Space Flight Center, Huntsville.

578,941—**Radiation, Inc.,** Melbourne, Fla., for digital command and system ground control network.

266,073—**Hughes Aircraft Co.,** Culver City, Calif., for modifications of existing telemetry and command stations.

151,133—**Northrop Corp., Nortronics Div.,** Norwood, Mass., for design, development, fabrication and delivery of four hermetically sealed rate gyroscopic packages.

155,000—**California Computer Products, Inc.,** Anaheim, Calif., for satellite-borne digital electronics subsystem.

139,100—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for high performance *Apollo* propulsion system study.

132,500—**Thiokol Chemical Corp.,** Elkton, Md., for rocket motors.

124,040—**Martin Marietta Corp.,** Denver, for engineering concept study to define and develop test facilities and requirements for the Mississippi test facility of the Marshall Space Flight Center.

123,920—**United Electrodynamics, Inc.,** Pasadena, Calif., for four EA pulse code modulation airborne telemetry systems.

101,977—**Ling-Temco-Vought, Inc., Astronautics Div.,** Dallas, for orbital rendezvous program.

100,000—**Varian Associates, Inc.,** Palo Alto, Calif., for rubidium vapor magnetometer instrumentation for second generation scientific satellites.

87,617—**General Dynamics Corp.,** San Diego, Calif., for study of sputtering mechanism under ion propulsion conditions.

84,469—**Dynatronics, Inc.,** Orlando, Fla., for pulse code modulation telemetry ground stations.

59,560—**Martin Marietta Corp.,** Denver, for design criteria modifications pertinent to wind-induced oscillations of the *Saturn* booster vehicle standing in the vertical launch position.

56,000—**NRC Equipment Corp.,** Newton Highlands, Mass., for one space simulator.

38,015—**University of Michigan,** Ann Arbor, for high altitude environmental measurement study.

24,154—**Wylie Laboratories,** Huntsville, Ala., for study to compare acoustic prediction methods of clustered solid engines and liquid engines.

ikon Corp., Natick, Mass., for performance of basic research into the revolutionary dispersion-strengthening technique for producing ultra-stable, high-temperature superalloys (undisclosed amount).

INDUSTRY

.000,000—**Ling-Temco-Vought, Inc., Temco Electronics Div.,** Dallas, from **United Technology Center,** for a continuation of the development of fluid injection valves for 120-in. dia. solid booster for the *Titan III.*

,500,000—**Gianinni Controls Corp.,** Duarte, Calif., from **North American Aviation, Inc.,** for development of a system for measuring propellants under conditions of weightlessness.

00,000—**General Dynamics/Electronics,** San Diego, from the **California Institute of Technology's Jet Propulsion Laboratory,** for development, fabrication and test of radar subsystems for *Ranger* spacecraft.

74,000—**Fairchild Stratos Corp.,** Manhattan Beach, Calif., from the **Boeing Co.,** for pneumatic actuation systems for the *X-20* spacecraft.

$300,000—**OPTOmechanisms, Inc.,** Plainview, N.Y., from the **Burroughs Corp.,** for a data display system utilizing the firm's camera-rapid film processor-projection system to be used as part of the NORAD 425L system at the Colorado Springs Group II facility.

$105,000—**Systems Engineering Laboratories, Inc.,** from **ARO, Inc.,** for a high speed data acquisition system to be used for testing rocket engines at the AF's Arnold Engineering Development Center.

$100,000—**Electronic Memories, Inc.,** Los Angeles, from the **Sperry Rand Corp.'s Sperry Utah Div.,** for development and delivery of an airborne severe environment memory system.

REQUEST FOR BIDS

GENERAL PROCUREMENTS

U. S. Naval Ordnance Laboratory
White Oak
Silver Spring, Md.

Dummy guided missile, MK 34, Mod. O. Prices requested on quantities of 12, 16, and 20 each, plus spare parts. Missiles will not include motors or guidance systems. It will include all electrical cables, switches, timers, explosive fittings and related components. Overall lengths of the assembled item will be approximately 20 ft. with a maximum diameter of approximately 21 in. The unit will consist of housing, case and float sections. The case will be fabricated mild steel, ½-in. thick, finished, and the housing of ⅜-in. mild steel. The float will be of ⅜-in. aluminum and will include aluminum casings. Types of work involved will include plate fabrication, heat treating, large, medium and precision machining, casing, pressure testing, cable molding, molded plastics, electrical assembly explosive loading, etc., as well as general machine and assembly operations. There are approximately 400 drawings to a set for a $50 refundable deposit. Requests for the invitation for bid must be received by 7/29/63 and must be accompanied by a check made payable to the U. S. Naval Ordnance Laboratory. A bidders' meeting for clarification purposes will be held on 8/13/63 at 9:30 AM, EDT, at the Naval Ordnance Laboratory, White Oak, Silver Spring, Md. Questions pertaining to this procurement will be answered only at this meeting. IFB 60921-1-64B. Bid opening Sept. 3.

Procurement Div.
Aberdeen Proving Ground, Md.

Negotiations being conducted with Aircraft Armaments, Inc., Cockeysville, Md., covering the preparation of the Ballistic Research Laboratories portion of Nuclear Reactor Containment Handbook. This notice is for informational purposes only. RFP not available.

U. S. Army Missile Command
Procurement and Production
Special Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXDA

For continuation of contract with Electronic Associates, Inc., Long Beach, N.J., covering rental of an electronic analog computer system. This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.

Secondary Item Branch
Procurement Div.
U. S. Army Missile Command
Redstone Arsenal, Ala.

Blast tube and nozzle assembly. Fed. Stock. No. N/A. Ord. Part No. 8034291—968 each. IFB AMC(Z)-01-021-64-518. Bid opening 8/7/63. Drawings and bid sets available from nearest procurement district.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston, Tex.
WA 8-2811, Ext. 7351

Negotiations will be conducted with North American Aviation, Inc., Space and Information Systems Div., 6001 Gulf Freeway, Houston 23, Tex., for a design study for the engineering investigation of modifications required to the *Apollo* spacecraft to extend mission capabilities. RFP MSC-63-745P. Note: For information only. No RFP available.

Negotiations will be conducted with the Marquardt Corp., 16555 Saticoy St., Van Nuys, Calif., for fabrication of 100-lb. thrust radiation-cooled thrust chambers—8 each. RFP MSC-63-744P. Note: For information only. RFP not available.

Atlas Procurement Div.
Guidance Branch
Norton Air Force Base, Calif.

Order 04-607-64-5 against existing contract AF 04(607)7907 with Burroughs Corp., Radnor, Pa., is in process. This procurement is for modification kits for the SM-65 *Atlas* weapon system as a result of a materiel improvement project. It is suggested that small business firms or others interested in subcontracting opportunities make direct contact with the above firm.

Purchasing and Contracting Officer
U. S. Army Missile Support Command
U. S. Army Missile Command
Redstone Arsenal, Ala.
Bldg. T-3152

Perform an 11-week study to determine the feasibility of a laser range finder. Job—IFB AMSMI-394-63. Bid opening 7/30/63.

National Aeronautics and Space Administration
General Research Procurement Office
Houston, Tex.

Negotiations will be conducted with the Bendix Corp., Bendix Aerospace Div., 177 Bendix Drive, South Bend, Ind., for a study to obtain impact and energy absorbing characteristics of crushable honeycomb for use in the design of landing gear shock attenuators for the landing vehicles in a space environment. RFP 63-740P. For information purposes only. No RFP available.

Negotiations will be conducted with Avionics Div., Bell Aerosystems Co., Bell Aerospace Corp., Buffalo 5, N.Y., for fabrication of an electronic cylindrical rendezvous target image generator—1 each. RFP MSC-63-743P. For information only. No RFP available.

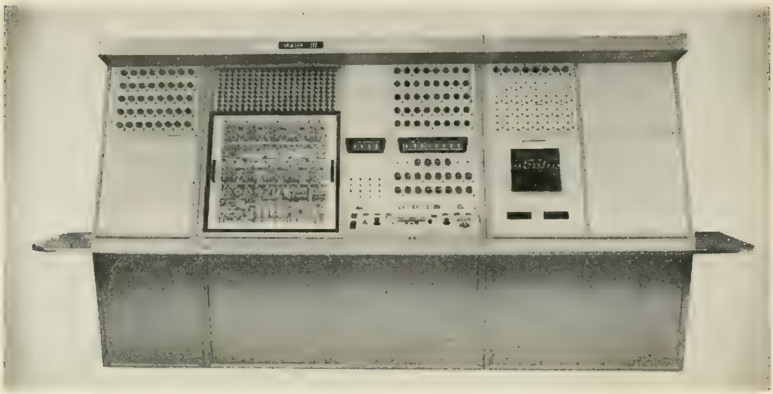
Directorate
Procurement and Production (SAPOSS)
Kelly Air Force Base, Tex.

6105-717-0644 (P/N 56553-501) motor—50 each. Applicable *GAM 77* missile used on reproducer (P/N 41574-501 in support recorder P/N 55231-501-11. No drawings or specs are available. Deliver Transportation Officer, Kelly AFB, Tex. RFP SA-3-56259 (Q) RFP due date 8-9-63. Item identified by North American Aviation, Inc., Autonetics Div., Anaheim, Calif., part number. Direct inquiries to J. P. Gilbert, WAlnut 3-5411, Ext. 5622, Kelly AFB.

6135-NC0450P-CM (P/N 256650) battery, warhead—239 each. Furnish identification data. Applicable *GAR-11* missile. No drawings or specs are available. Deliver Transportation Officer, Kelly AFB, Tex. Item identified with Hughes Aircraft Co., Florence and Teale Sts., Culver City, Calif., part number. Direct inquiries to Roy Curiel, WAlnut 3-5211, Ext. 42128, Kelly AFB.

Hawk Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

Necessary services to perform machining, potting and testing of EPU fuel sticks for the *Hawk* missile system. Duplication of initial investment in special tooling and facilities, requirement for specialized experience neecssary to assure compatibility with the system, plus nonavailability of adequate documentation at this time precludes award to other than Raytheon Co., Lexington, Mass., prime contractor for the *Hawk* missile system for these items. All inquiries relative to subcontracting should be referred to the above source.



New Product of the Week: Analog Computer

Computer Products, Inc., has developed a new Analog Computer. The Mark III features the capability of having all necessary computing elements for a full computer system housed within a single console. This includes 200 operational amplifiers, 180 potentiometers and 60 multiplier products. The Mark III has the capabilities for real time, rep-op, iterative and hybrid applications, and includes three-mode all solid-state amplifier switching and solid-state serial entry address system. Printed circuits are used for all plug-in components and digital packaging techniques are employed. Amplifiers and networks are installed on swing-out racks in the rear of the console. Specially designed oven permits adjustment of the capacitors without opening the oven.

Circle No. 225 on Subscriber Service Card

Fluorescent Penetrants

Two families of Zyglo fluorescent penetrants—with an impact resistance at 72 ft/lbs—have been developed by Magnaflux Corp. to provide superior flaw detection in testing critical aerospace components used in liquid oxygen systems.

The penetrants, used to detect small surface cracks, pores and other discontinuities, are specially designed to minimize the possibility of detonation resulting from residual penetrants.

In liquid oxygen rocket motor systems, flow control valves open and close rapidly, causing pressure changes equivalent to violent impact. This impact can cause detonation of foreign matter such as dirt, oil, or a thin film of normal oil-based low impact resistant penetrants if left on the material after testing.

Circle No. 226 on Subscriber Service Card

Epoxy Compound

A high temperature epoxy compound, Roplast R-504, has been developed by Rotacts, Inc., for use in making slip-rings that are subject to severe mechanical service on critical military equipment.

The compound bonds permanently to gold collector rings, as well as to lead wires. It greatly increases the structural strength of the slip-ring assembly when subjected to high shock and vibration through wide temperature extremes from −70° to 220° C. No volatiles are emitted under high temperatures and vacuum operating conditions.

Circle No. 227 on Subscriber Service Card

Integrated Amplifier

General Electric Co. has developed an integrated reference amplifier that performs the same circuit functions as a separate transistor and zener diode.

The device performs the functions of a voltage reference and an error voltage amplifier in either a regulated- voltage or regulated-current supply. Its integrated structure reduces the effects of long- and short-term drift of the reference voltage normally encountered in regulated power supplies.

A method of defining temperature coefficients has been developed in conjunction with the integrated reference amplifiers. By using this method of definition, temperature coefficients as low as ±0.001%/°C over the entire temperature range are possible. The method involves plotting the change in reference voltage versus temperatures on an x-y recorder.

Circle No. 228 on Subscriber Service Card

IF Amplifier

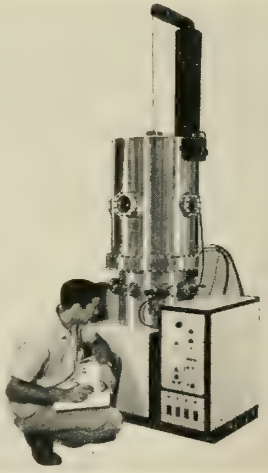
RHG Electronics Lab. has availabl an advanced performance miniatur tube IF amplifier. The EV series offe high performance for military applications. The features provided, include ¼ watt IF output capability, video cathode-follower output, MGC control line, AGC control line, IERC heat dissipating tube shields.

Circle No. 229 on Subscriber Service Card

Bell Jar System

An integrated, bakeable system Model 181OBJ, has been developed by Mount Vernon Research Company to use the MVRC Model 1810 ultrahigh vacuum pump to achieve a pressure of 10^{-9} torr in an 18 x 24-in. or 18 x 30-in stainless steel bell jar. The pump provides high speeds in the bell jar for space simulation, materials studies or film preparations.

The bell jar is polished and includes an internal heater, insulation and temperature controller and is lifted by a pneumatic system. Twelve bakeable feedthrough ports are provided, and a variety of accessories are available. A pressure of 10^{-9} torr can be achieved with minimum operator techniques and a pressure of 5×10^{-9} torr in less than three hours. The speed in the bell jar is 1,600 liters/sec for air and 19,000 liters/sec for vapors using the large cryopump.



Circle No. 230 on Subscriber Service Card

Pulsed Light Systems

A ultrahigh-speed pulsed light source system for use in transient photo-induced phenomena experimentation is being marketed by Electro-Optical Instruments, Inc.

Model STU-92 is applicable for research in organic and semiconductor material lifetimes, energy states and carrier mobilities.

Heart of the instrument is a Kerr cell pulser which provides arbitrary optical pulse shapes from an integrated flash lamp with output durations and triggering capability in the nanosecond time range. Completely system-engineered, the instrument incorporates extensive electrical shielding to minimize radiated RF noise so that measurements can be made on high resistivity samples as well as those which exhibit only weak response.

The STU-92 system essentially consists of a flash lamp and a Kerr cell electro-optical modulator. Both units have individual power supply and trigger pulser systems.

Circle No. 231 on Subscriber Service Card

Silicon Optical Detectors

Three basic types of Silicon Optical Detectors available from Electro-Nuclear Laboratories offer controlled and extended spectral responses from 5,000 to 9,000Å. ED Series 900 provides the normal silicon spectral response peaking at 9,000Å. ED series 5500 and -9000 dectectors provide respectively optional peaking at 5500Å and a broader, less peaked response over the range of 5,000 to 9,000Å.

Detectivity ranges from 10^{12} to 10^{13}. Response is in the megacycle range. Sensitive areas are defined with optical precision, typically ±0.00005 in.

Circle No. 232 on Subscriber Service Card

Airborne Radars

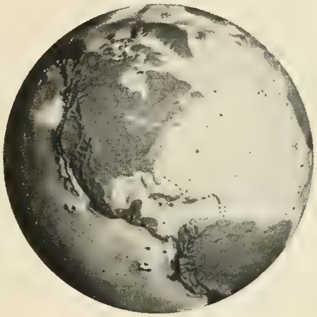
Two airborne radars one-third the weight and 20 times more reliable than current systems are being developed by Autonetics Div. of North American Aviation, Inc.

One of the systems, designated R-45, a multi-mode radar. The other, R-47, an all weather radar capable of following terrain.

Both systems make maximum use of 0 standard microelectronic circuits developed by Autonetics, as well as computer analysis of standard parts and circuits.

The R-45 is for use in transports or high speed attack aircraft, operates at altitude of 250 to above 60,000 ft. and speeds up to Mach 2.5.

Circle No. 233 on Subscriber Service Card



Instrumentation Planning Engineers

Tomorrow's "birds" at the Atlantic Missile Range will require sophisticated new range instrumentation systems to measure their performance. Insuring that the Range can meet the data acquisition, data handling, and data support requirements of each new launch in the next five years is the responsibility of Range Planning Engineers with Pan Am's Guided Missiles Range Division.

Their assignment . . . to plan a range which can support Titan III, Gemini, Apollo, and scores of future programs . . . makes demands on all areas of technology. Operational analysis, computer systems, celestial mechanics, CW and pulse radar, optics, communications, underwater sound, ship instrumentation, meteorology, logistics, range safety are just a few of the disciplines involved in their programs.

And, these programs are diverse. For example, plans are under way for:

- simultaneous range support for time-critical complex missions.
- increasing the accuracy of pulse and CW radar systems through ultra-precise and near-real-time calibration using satellites.
- the use of instrumentation satellites to escape from the effects of the earth and its atmosphere.
- the integration into the Cape Canaveral complex of a new Central Control Operation, to handle the increased scope of orbital and space missions.

Experienced Engineers interested in joining this effort are invited to write Dr. Charles Carroll, Dept. 56G4.

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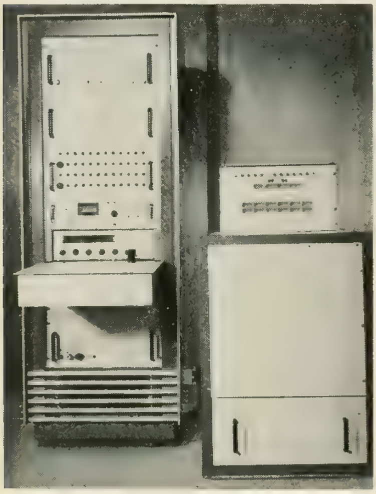
Circle No. 3 on Subscriber Service Card

Digital Circuits Tester

The Instrumentation department of Fairchild Semiconductor has available the Series 4000 Integrated Digital Circuits Tester.

The Series 4000 Tester is a state-of-the-art instrument for the characterization of basic digital building-block elements. It is designed to measure functions, voltages and currents of nearly every digital logic device.

Features of the unit are drift-free solid-state circuitry, plug-in modular programming and a series of optional adaptations including data logging, automatic sorting and digital display readout. The test conditions can be pre-set for typical- and worst-case conditions of the input and output specifications of the microcircuit.



Circle No. 234 on Subscriber Service Card

Proximity Switch

A magnetically-actuated proximity switch with a service life expectancy of 1-billion cycles has been developed by Wintriss Controls.

The unit is available with either normally open or normally closed contacts and is supplied with a screw cap sealed plug-in socket, and operates when the magnet supplied with it is within ¼ in. of the probe surface, and releases when the magnet is withdrawn 2 in. from the probe. It is rated at 50 volt-amps ac or 25 watts dc, and exhibits a 500-v breakdown voltage Actuating time and contact bounce time are both 0.001 second or less.

Circle No. 235 on Subscriber Service Card

Pressure Controller

An instrument, which controls pressure or partial pressure from 10^{-11} torr up to one atmosphere and is bakeable to 450° C for minimum contamination, is available from Granville-Phillips Company. The throughput of a single unit is large enough to swamp a 50,000 liter/sec pump at 10^{-3} torr and automatically adjusts to control small laboratory systems operating at the lowest pressures attainable. Applications are in ion sources of mass spectrometers and high energy particle accelerators, space simulators, backfilling, process control or wherever manual control of pressure is now used.

Circle No. 236 on Subscriber Service Card

Fiberglass Material

A fiberglass reinforced laminated material with structural strength, light weight, and high impact resistance is now available from Air Logistics Corp.

The Stratoglas 600SI is used in space vehicles, and land and sea vehicles.

Stratoglas 600SI sheet material can be readily cut, sheared, drilled or punched without special tools. Conventional butt, lap and scarf joints can be made, with leakproof and pressure-proof integrity, using normal reinforced plastic fabrication techniques. The material is available in 48-in.-wide rolls up to 300 ft. long, and in normal thicknesses of 0.020, 0.030 and 0.040 in.

Circle No. 237 on Subscriber Service Card

Delay Lines

Superconductive delay lines, for use as "scratch pad" memory functions for high speed computers, have been developed by the Electronic Systems & Products Div. of Martin Co.

The delay lines give precise delay times from 100 to 2,000 nanoseconds, with an insertion loss of less than 1 db per microsecond with 8 nanosecond pulses. Rise time is under 0.5 nanoseconds.

At a 125-mc clock rate, a line providing a delay of 800 nanoseconds has a 100-bit storage capacity. A one-microsecond delay line stores 125 bits at 125 mc.

Circle No. 238 on Subscriber Service Card

Gaussmeter Adapter

Scientific Columbus, Inc., has developed a gaussmeter adapter for a d-c vacuum tube voltmeter. The Model MMA-1 consists of a magnet sensor, power supply and control system. The device is calibrated to have an output of 1 millivolt per 100 gauss. Provision is made for increasing this sensitivity to 3 millivolts per 100 gauss. Readout is accomplished by connecting the unit to any high impedance d-c VTVM. Accuracy of the unit is ±3%, and it is useful to 30 kilogauss.

Circle No. 239 on Subscriber Service Card

Silicon Transistor

Motorola Semiconductor Products, Inc., is marketing a silicon PNP transistor, manufactured by the annual transistor fabrication process which has met a 0.001%/1000-hour reliability requirement.

The annular process, used in the fabrication of the 501M transistor provides a degree of freedom from adverse surface effects for semiconductor components and eliminates the voltage-limiting "channeling" tendencies prevalent in earlier passivated PNP silicon transistors.

Circle No. 240 on Subscriber Service Card

Micro Diode Assemblies

MicroSemiconductor Corp. has available high reliability silicon micro diode assemblies for core driver and other high current computer applications. Pulse current as high as 1.5 amps and recovery times as low as 0.002 microsecond are available. Inverse operating voltages are high. Junction capacity is 2 picofarads.

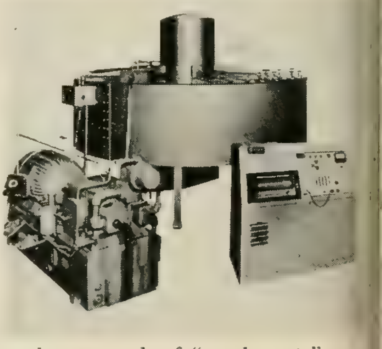
The assemblies are encapsulated or not, depending on the requirements for handling, and are capable of meeting or exceeding MIL-S-19500C and MIL-STD-750 requirements.

Circle No. 241 on Subscriber Service Card

Programmable Centrifuge

A fully programmable centrifuge, which meets the high-rise time-test requirements of aerospace industries, is available from Genisco.

The Model 1039 accelerates from 0 to maximum 150 g's within 5 to 10 seconds, depending on its test package load. The unit delivers a rise rate of 10 g's per second minimum, allowing for hydraulic fluid "roll off" at the start and to the approach of "steady state" conditions.



The unit can be remotely or locally controlled, and handles test packages weighing up to 50 lbs. It is powered by a 40-hp hydraulic motor pump and transmission.

Circle No. 242 on Subscriber Service Card

Coaxial Connectors

General RF Fittings, Inc. is marketing GM series of microminiature, threaded coupling, RF coaxial connectors.

Designed for use with the lightweight cable in missile, satellite applications, the series feature a protective inger design carrying ground completely away from the contact through the connector. Electrical specifications are voltage: max. 250 vrms. at 60 cycles; impedance: 50 ohms nominal.

Circle No. 243 on Subscriber Service Card

Digital Pressure System

A rugged pressure system offering aboratory accuracy under field condiions is being marketed by International Resistance Co. A servo-controlled digital eadout facilitates the system's use.

Accuracy of ±0.15% is maintained by a built-in compensation network that djusts for changes in line voltage, frequency and ambient temperature. The ransducer has infinite resolution; the ystem, excellent repeatability.

Standard pressure ranges are from -20 in. of water to 0-600 psi; higher nd lower ranges are available; power equirements are 115 volts, 60 or 400 ps. An explosion-proof housing is available for the pressure transducer.

Circle No. 244 on Subscriber Service Card

Solid-State Serializer

An accessory unit designed to exend the flexibility of its solid-state igital voltmeters has been announced y Electronic Associates, Inc. The Series 010 Serializer is a solid-state, highpeed, parallel-to-serial converter. It is esigned to accept parallel inputs from igital voltmeters and convert these gnals into serial data form for driving aper tape units, electric typewriters, ard punches and similar print-out quipment.

The Series 5010 Serializer provides a standard word format which includes up to 12 characters, the first four being 6-bit alpha-numeric for address, and the remaining eight used for BCD data. Flexible programs can be achieved through the use of a replaceable plug-in code translator card, and word format can be varied by means of a removable patch block on front of the panel.

Circle No. 245 on Subscriber Service Card

High-Power Heliax Cable

Andrew Corp. has designed and produced a flexible, air dielectric cable for high-powered communication systems. Type H9-50 features inherent flexibility of heliax construction with its large size and power handling capability of 826-kw peak power. The convoluted inner and outer conductors of high conductivity copper permit easy bending around obstructions, simplifying installation and eliminating electrical discontinuities found in broken length installations. Produced in continuous lengths, Type H9 is available in lengths up to 1,000 feet. Splice free construction contributes to an exceptionally low VSWR up through 950 mc. Flanged-end fittings for Type H9 mate with 6⅛-in. EIA standard flanges and inner connectors.

Circle No. 246 on Subscriber Service Card

Strip Chart Digitizer

The Strip Chart Digitizer is being marketed by UGC Instruments, a division of United Gas Corporation. The unit is an optical scanning system for translating and converting strip chart data to digital data. Scans which obtain the positions of all traces are made at the rate of 25 to 30%/sec.

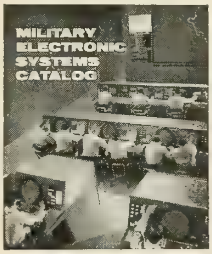
Accuracy is approximately 0.1% as compared with 1.0% of full scale quoted for semi-automatic digitizing devices. The Electroscanner Strip Chart Digitizer is capable of reading a minimum line width equal to 0.010 in. and a minimum line separation of 0.015 in.

Circle No. 247 on Subscriber Service Card

Solid-State Counters

Eldorado Electronics has available two 2.5 mc solid-state counting instruments, Model 734, a frequency/multiple period counter (to 10^5 periods), and Model 735, a universal counter/timer (with multiple period to 10^7 periods). Both instruments have a maximum counting rate of 2.5 mc with six decades and time interval measurement range of one μsec to 10^7 seconds. Input sensitivity is 100 mv rms and input impedance of one megohm per volt.

Circle No. 248 on Subscriber Service Card



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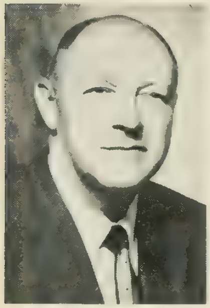
names in the news


ALLEN

HUMMEL

PFEIL

WALSH

GREENE

Joseph R. Piselli: Promoted to director of engineering for the Aerospace Rockets Div. of Textron's Bell Aerosystems Co., Buffalo, N.Y.

Robert E. Allen: President of Fuller & Smith & Ross, Inc., named a director of Reeves Industries, Inc. (AMEX), New York City.

Allen R. Hummel: Appointed Southwest regional manager of Telemetrics, Inc., Gardena, Calif.

John F. Garde, Jr.: Named president of Sanderson & Porter, Inc., New York City. **P. B. Taylor, Jr.** appointed vice president-engineering services. **Stanley S. Mleczko** elected to the board and appointed vice president-engineering and **William J. Monaco**, manager-construction, elected to the board.

R. J. Pfeil: Elected president of Koontz-Wagner Electric Co., South Bend, Ind.

David J. Logan: Named vice president-engineering of the Gerber Scientific Instrument Co., South Windsor, Conn.

D. C. Giles: Appointed executive vice president for the Pure Carbonic Co., New York City.

Dr. Walter G. Wadey: Appointed chief scientist of Washington Technological Associates, Inc., Rockville, Md.

J. Paul Walsh: Elected president of the Matrix Corp., Arlington, Va.

James M. McCarty: Appointed manager of engineering, West Coast Operations, of the Perkin-Elmer Corp., Electro-Optical Div., Costa Mesa, Calif.

Eugene Jonas and **Richard Lieb:** Elected to the board of directors of Paradynamics, Inc., Huntington Station, N.Y.

William G. Fallon, Jr.: Named president of Norton International, Inc., Worcester, Mass.

Gerald C. Johnson, Jr.: Appointed marketing manager for the central operation of Sylvania Electronic Systems Div. of Sylvania Electric Products, Inc., Buffalo, N.Y.

W. K. Budd: Appointed an application engineer in the Aerospace Div. of Vickers Inc. Div. of Sperry Rand Corp., Detroit, Mich.

Edward O. (Neil) Baxter: Appointed assistant manager for ordnance and aerospace ground equipment at Thiokol Chemical Corp.'s Eastern District Office, Washington, D.C.

Joseph D. Ellis: Appointed director-marketing and contracts at ARINC Research Corp., Washington, D.C. **John E. Otto** appointed sales manager.

Kenneth T. Larkin: Named director of engineering at Lockheed Missiles & Space Co., Sunnyvale, Calif.

William E. Greene, Jr.: Appointed manager of Scientific Data Systems' Boston office.

Charles O. Cary: Named special assistant to the senior vice president for marketing of Hazeltine Corp.'s Electronics Div., Little Neck, N.Y.

James S. McKeown: Named western regional sales manager for Packard Bell's Computer Div., Los Angeles.

Robert N. Palmer: Appointed applications engineering manager, research and development, of the Tube Div. of Varian Associates, Palo Alto, Calif.

Herman Erichsen: Appointed manager, production engineering, for Data Sensors, Inc., Gardena, Calif.

Edward J. Carney: Named manager of advertising and sales promotion of the Distributor Products Div. of International Telephone and Telegraph Corp., Lodi, N.J.

Charles S. Hazard: Appointed director of production at American Machine & Foundry Co., New York City.

Edgar R. Brastow: Promoted to chief engineer of the Gyro Div. of Giannini Controls Corp., Duarte, Calif.

Dr. James L. Palmer: Named manager of the electron tube section of the Bendix Corp.'s Red Bank, N.J., division.

B. L. Sarahan: Promoted to manager of International Business Machines Corp.'s Federal Systems Div., Houston.

Robert K. Dietly: Named advertising manager for Lord Manufacturing Co., Erie, Pa.

Col. George B. Kaiser (USAF ret.): Appointed president of Editorial Engineering, Inc., (technical writers and publishers), Houston.

E. Edgar Fogle: Elected a vice president of Union Carbide Corp., New York City.

Robert E. Carter: Appointed to the Support Systems Div. of the Research Analysis Corp., Bethesda, Md., as an operations analyst.

Joseph J. Lipper: Named assistant to the president of Aerojet-General Corp. with offices in New York City.

Edmund C. Lund: Named vice president and general manager of Minneapolis-Honeywell's Ordnance Div., Hopkins, Minn.

James A. Webb: Appointed manager of purchasing for Sparton Electronics Div. of Sparton Corp., Jackson, Mich.

E. R. Skaggs: Appointed manager-application engineering at Palomar Scientific Corp., Palo Alto, Calif.

Harry W. Kellogg: Appointed director of procurement at Quantic Industries, Inc., San Carlos, Calif.

James R. Steffey: Appointed manager of European operations of Rocket Research Corp. with headquarters in Paris.

George S. Trees: Appointed manager of operations-special products at the Oak Brook, Ill., offices of Chicago Bridge and Iron Co.

Ian H. McLaren: Appointed manager of Emerson Electric's Electronic Systems Dept., St. Louis.

R. T. MacFarlane: Appointed chief engineer at Graflex, Inc., Rochester, N.Y.

when and where

JULY

AIAA Torpedo Propulsion Conference, U.S. Naval Underwater Ordnance Laboratory, Newport, R.I., July 23-26. (Confidential)

International Congress of Biochemistry, Hilton and Americana Hotels, New York City, July 26-Aug. 1.

Toxicity in the Closed Ecological System, Sponsored by U.S. Navy's Special Projects Office and Lockheed Missiles and Space Co., Lockheed Research Laboratories, Palo Alto, Calif., July 29-31.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE, and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

Sixth Annual Institute of Missile Technology, sponsored by University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News*, Universtiy of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

963 Cryogenic Engineering Conference, sponsored by NBS and Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug 23.

AIME Electronic Materials Conference, Somerset Hotel, Boston, Mass., Aug. 26-28.

AIAA Simulation for Aerospace Flight Conference, Deshler-Hilton Hotel, Columbus, Ohio, Aug. 26-28.

AIAA Conference on Physics of Entry into Planetary Atmosphere, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

IEEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

8th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

National Symposium on Space Rendezvous, Rescue and Recovery, sponsored by American Astronautical Society and the Air Force Flight Test Center, Edwards Air Force Base, Calif., Sept. 10-12.

17th Annual National Convention & Aerospace Panorama, Air Force Assn., Sheraton-Park and Shoreham Hotels, Washington, D.C., Sept. 11-15.

Institute of the Aerospace Sciences, Antisubmarine Warfare Meeting, San Diego, Calif., Sept. 16-18.

American University, Institute of Electronic Information Display Systems, International Inn, Washington, D.C., Sept. 16-20.

Industrial Electronics Conference, sponsored by AIEE, IRE and ISA, Michigan State University, East Lansing, Mich., Sept. 18-19.

National Power Conference, sponsored by ASME, AIEE, and IRE, Netherlands-Hilton Hotel, Cincinnati, Sept. 22-25.

Aeroelastic and Dynamic Modeling Technology Symposium, sponsored by AF Systems Command's Aeronautical Systems Div. and the AIA, Biltmore-Hilton Hotel, Dayton, Ohio, Sept. 23-25.

Recently Acquired Knowledge of the Space Environment Meeting, sponsored by the XIVth International Astronautical Congress and the International Astronautical Federation with the cooperation of UNESCO and COSPAR, UNESCO House, Paris, Sept. 27.

IRE Canadian Electronics Conference, Toronto, Can., Sept. 30-Oct. 2.

OCTOBER

Society of Plastics Engineers, Regional Technical Conference on Reinforced Plastics and Chemical-Electronics Symposium, Cleveland-Sheraton Hotel, Cleveland, Oct. 1-2.

IAS Manned Interplanetary Exploration Meeting, San Francisco, Oct. 2-4.

American Institute of Electrical Engineers Fall General Meeting, Pick-Congress Hotel, Chicago, Oct. 6-11.

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State of the Union

WE ARE PLEASED to report that our suggestion of last week that this industry take the lead in carrying the case for the national space program to the people already is drawing interest from at least three major companies. It still is too early to say whether anything will come of these discussions but we fervently hope so.

Whether connected with the arrival of the dog days or not, there is a definite malaise abroad in the land as regards the space program. The forced resignation of D. Brainerd Holmes, the $500-million cut in the space budget proposed by the House Space Committee and public statements criticizing the space program all have contributed to an uneasy feeling about U.S. goals and objectives in space. Unless new life is infused into the program, this malaise all too easily can be translated into indifference.

This industry must take the primary responsibility, and take it immediately, for obliterating apathy about the space program.

We are going to do some plagiarizing from author John Steinbeck because he makes a telling point in his recent book "Travels with Charley," a survey of the American scene. Steinbeck tells of talking with a well-known and highly respected political reporter just before setting out on his trip across the U.S. The reporter had just returned from a grass-roots campaign tour.

"When I saw him," Steinbeck writes, "he was not happy, because he loves his country, and he felt a sickness in it."

The reporter told Steinbeck bitterly: "If anywhere in your travels you come on a man with guts, mark the place. I want to go see him. I haven't seen anything but cowardice and expediency. This used to be a nation of giants. Where have they gone? You can't defend a nation with a board of directors. That takes men. Where are they?

"Must be somewhere," Steinbeck said.

"Well, you try to root out a few," the reporter replied. "We need them. I swear to God the only people in this country with any guts seem to be Negroes. Mind you, I don't want to keep Negroes out of the hero business, but I'm damned if I want them to corner the market. You dig me up ten white, able-bodied Americans who aren't afraid to have a conviction, an idea, or an opinion in an unpopular field, and I'll have the major part of a standing army."

Steinbeck, too, found the same lack of conviction.

We ourselves have charged in these columns, that the nation is getting soft from its overabundance of riches. But we do not think the cause is hopeless. We believe that the American people, properly informed and inspired, will respond. They responded, briefly and enthusiastically, to the initial drive and enthusiasm of the Kennedy Administration in this field as in others.

But in recent months, the Administration—seeking the roots of political power elsewhere in the between-elections period—has neglected to keep the spark fanned. In any event, the attention and interest of the Administration must by nature be diversified. This industry faces no such other distractions.

As we said, we are convinced the American public will respond. But if it does not, if the American people must be dragged kicking and screaming into the Space Age, then this industry must do the dragging. If the bulk of Americans are to be followers, then we must provide the leaders. If giants are needed, then this industry must provide the giants.

If that is not enough, if it is necessary to sell the space program to the American public the same way soap and cigarettes are sold, then let's sell it that way. Let's sponsor those miserable, debilitating programs on television, let's buy advertising pages in the slick magazines, let's give away coupons, free rides in a space simulator or whatever is required.

Let's convince Danny Kaye, Johnny Carson, Steve Allen, Bob Hope, Arthur Godfrey and Art Linkletter that space is the nation's most important objective and get them to sell it for us.

Let's hire blimps and airplanes to pull messages across crowded football stadiums, let's buy the outfield fences in baseball stadiums and let's clutter up the country roads with outdoor billboards.

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Let's hire huge public relations firms to surreptitiously plug space, let's back the political candidates who favor the space program, let's send speakers on tour to Kiwanis and Lions and Rotary.

We don't for a minute believe such extremes will be necessary. But we must start now to do whatever *is* necessary.

Steinbeck's friend said to him: "There used to be a thing or a commodity we put great store by. It was called the People. Find out where the People have gone. I don't mean the square-eyed toothpaste-and-hair-dye people or the new-car-or-bust people, or the success-and-coronary people. Maybe they never existed, but if there ever were the People, that's the commodity the Declaration was talking about, and Mr. Lincoln. . . ."

"Maybe the People are always those who used to live the generation before last," Steinbeck replies.

We don't think so. They're out there. We just have to wake up those sons and grandsons of the frontiersmen. This is indeed a time for the summoning of giants. The industry must proudly lead the nation into the Space Age—or if need be, drag it there.

William J. Coughlin

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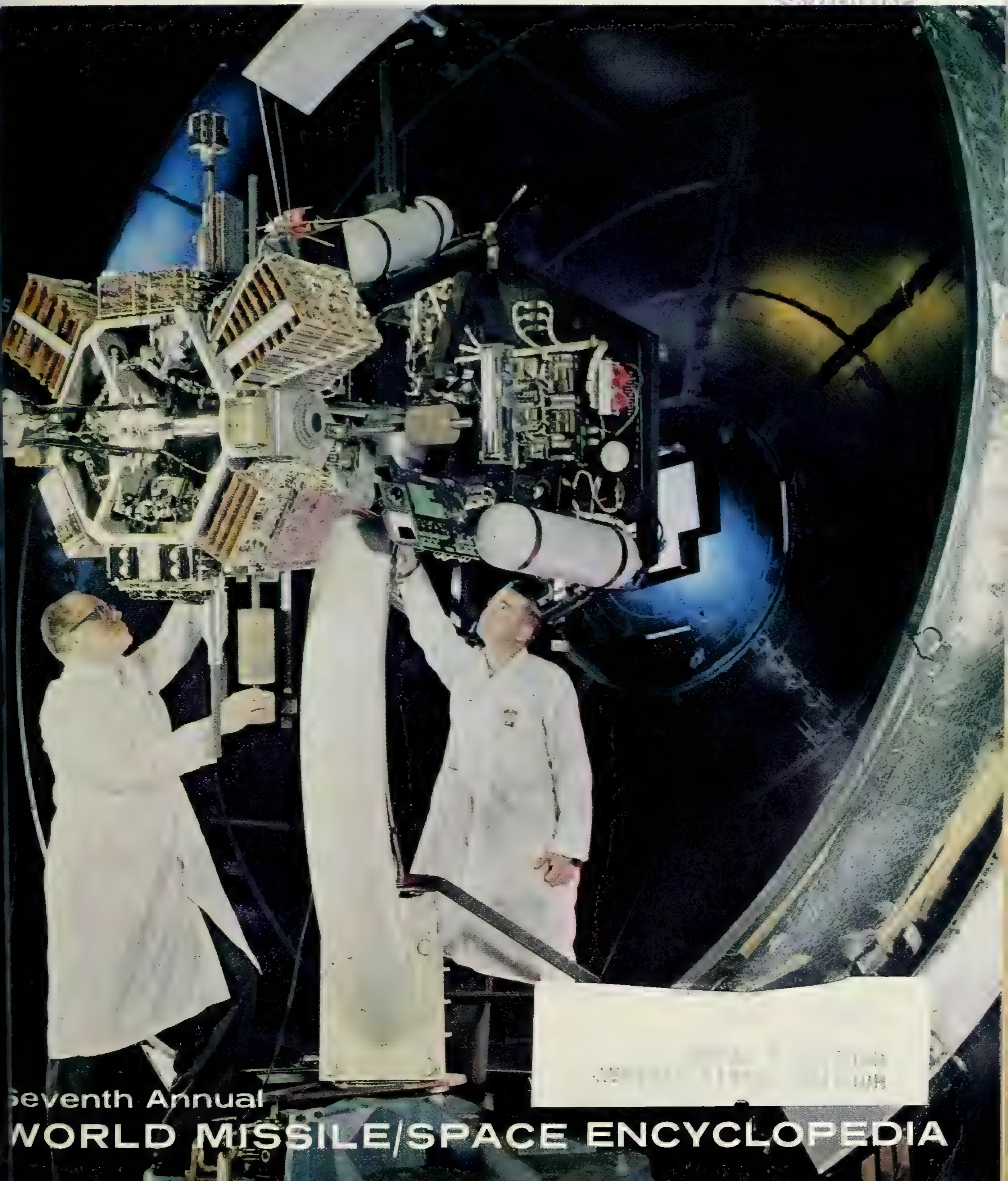

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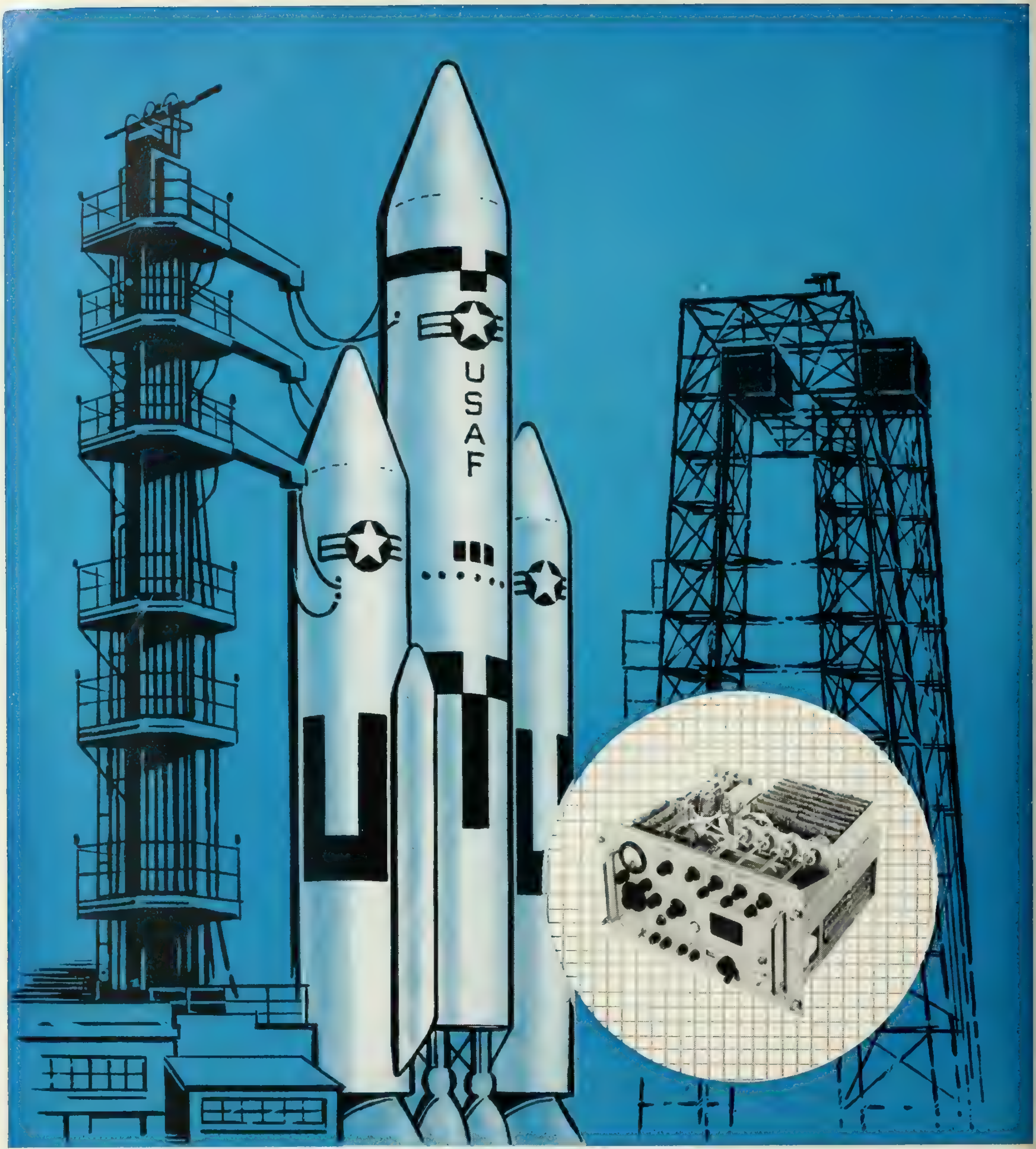

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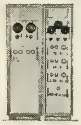

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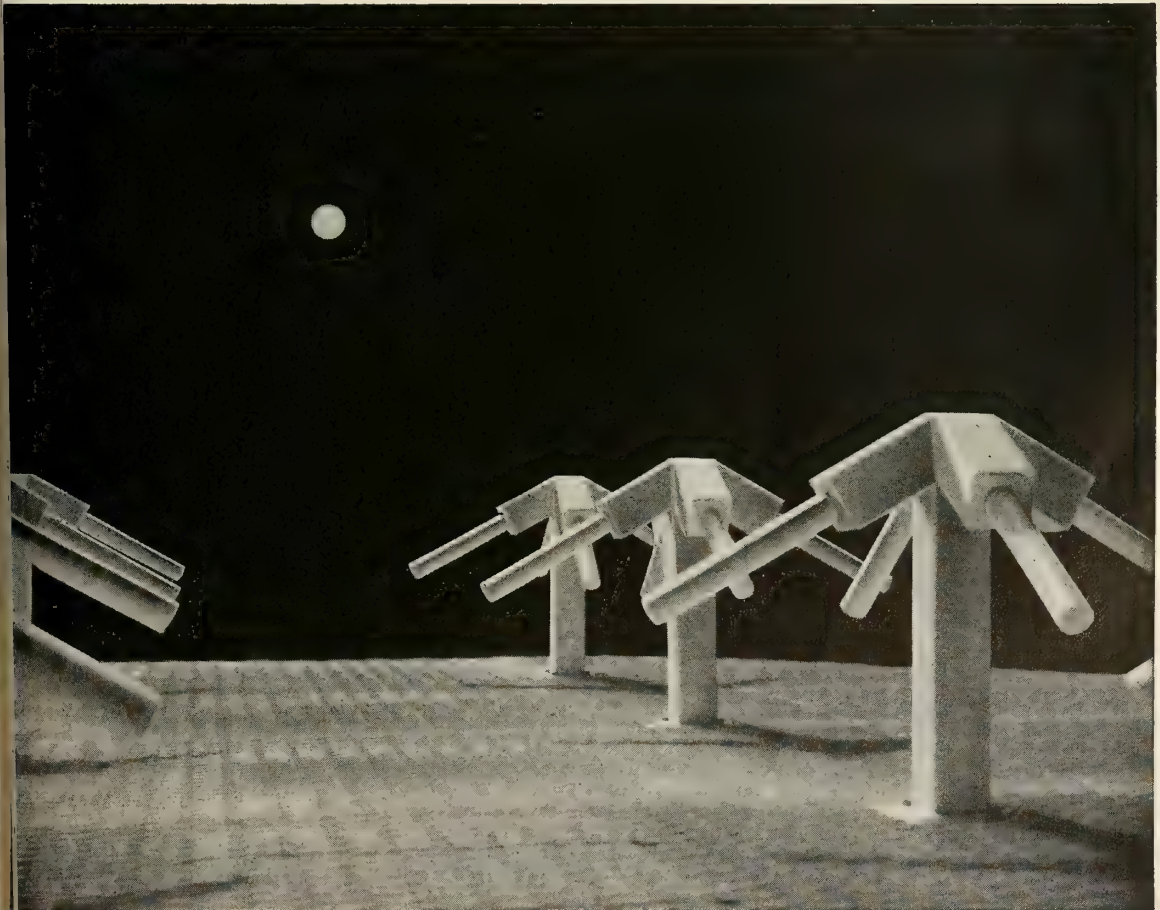

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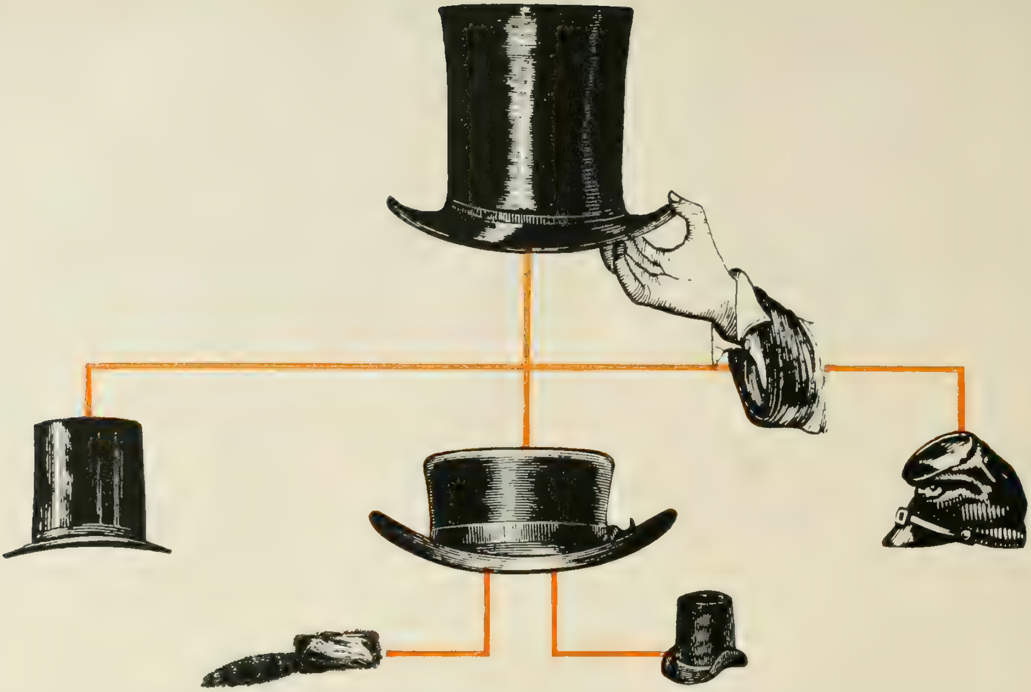

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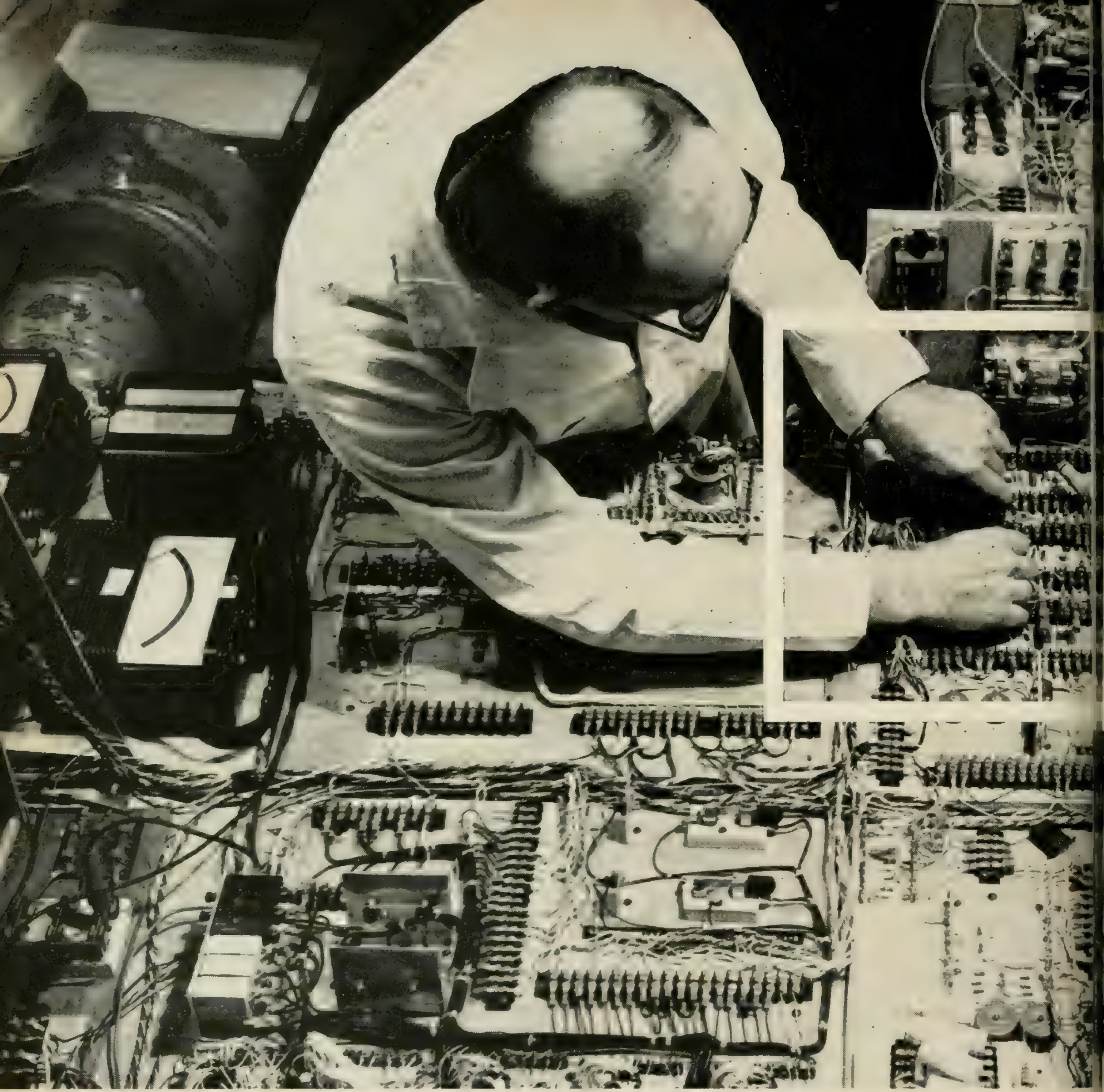

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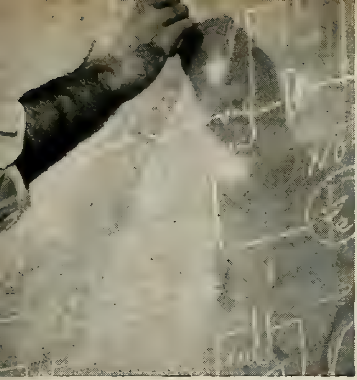
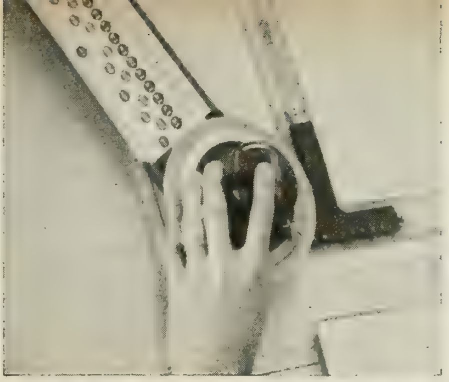

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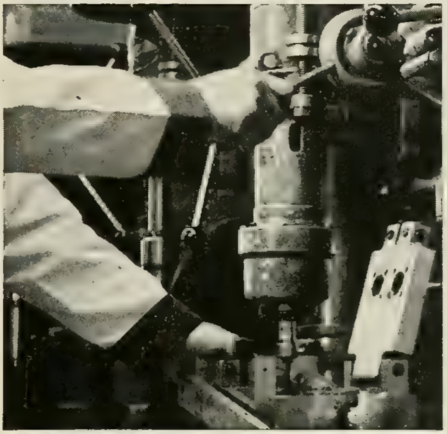
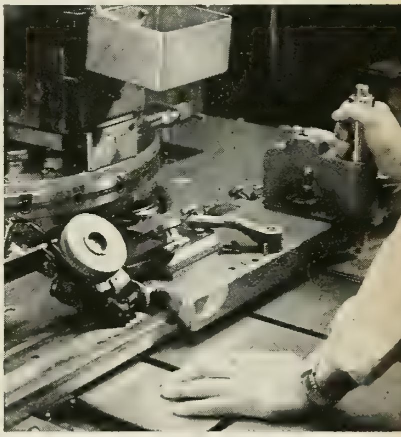

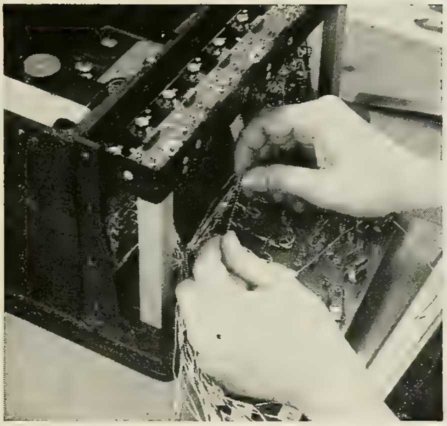
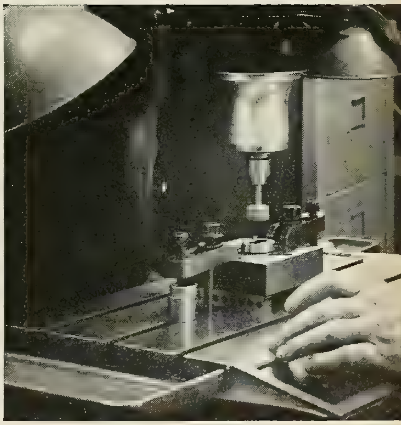

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Promoting Space

To the Editor:

I would like to applaud your editorial.

All too often we hear the cry—even in Huntsville!—that "all that money" being spent to place an astronaut team on the Moon could better be spent on "a cure for cancer, medicine, or other worthwhile projects."

Similar cries have been voiced by astronomers and others abroad who do not have a space program (although these people are very glad to receive our hard-earned data). Recently Sir Bernard Lovell suggested that Soviet scientists are not too certain about a lunar program, the unspoken inference being that if the Russians quit we have no reason to go on.

This is all nonsense. If every cent were freed from astronautics, not one cent would be re-routed into medical research. Nor would we get the medical fallout from the space program that we now have. Most readers of your magazine realize this.

You wish to sell the public? What you need is a good public relations setup. Most of those we have today show thrilling pictures of rocket takeoffs, and let it go at that. Once you have all that enthusiasm whipped up. even if only momentarily, it should be followed up with answers to the single most important question that pops into the viewer's mind: "What's in this for me?"

A series of programs, preferably in prime television time, sponsored by all the major aerospace industries, should be ini-iated—perhaps on the format of "Indus-ry on Parade," which captured a lot of iewers in its prime. Such a program hould concentrate on the "fallout" of the pace program, such as the improved medi-al monitoring equipment, the safety to fe and property afforded by the *Tiros* atellite data, and even the new cookware erived from re-entry materials research.

Men can be highly motivated by ab-tract ideals, reference the Crusades and he American Revolution. However, for long-haul effort such as our space pro-ram we must appeal to the more "practi-al" side of the average American, and how him all the benefits of the space pro-ram—what these afford *him*.

Let's face it. Most of us in the industry re sold on the space programs. We have ome idea of what this will do for us, both hort-range and long-range.

But, just as obviously, everybody does *ot* know about it, and your idea of some tegrated public relations is good. *Please,* owever, if and when such an informa-on TV series is formulated, don't let's oncentrate only upon the adventure as-ects. Be "practical." Show the fallout enefits. Take Space off its ivory tower nd show what a force for betterment of e individual standard of living it can be.

Stephen A. Kallis, Jr.
Chrysler Space Division
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Huntsville, Alabama

The Relationship

To the Editor:

After reading your rundown (M/R, June 10, p. 21) on the Stanford Research Institute report to Aerospace Industries Association, "The Industry-Government Aerospace Relationship," and your July 8 editorial, I had the feeling that here was a very worthwhile document every person in the Aerospace Industry *must* read and study. I have done just that.

Certainly the problems associated with the current stressed relationship, and with the increased government regulation of defense and space R&D contracts, and the failure of industry to perform as *prime contractor* on these contracts where they were so designated . . . all were well developed and forcefully presented.

Upon further examination of Volume I and parts of Volume II, I have considerable apprehension about AIA President Karl G. Harr's *hope* that "the study will pave the way for a joint industry-government effort to improve the relationship."

Why? Because, despite all of the research that went into this study, the basic cause of the deterioration of the relationship was not uncovered.

Why did industry fail to deliver systems as promised?

Why didn't industry perform as prime contractor when charged with that responsibility?

Why didn't industry enter into *workable* working partnerships with government on the CPFF contracts covering blocks of R&D hardware requiring technological breakthroughs?

Why was there such a devoidance of real, accurate, timely and understandable communications—vertically down and up *and* horizontally both ways at *all* levels?

I would like to ask your opinion as to whether the report would have been enhanced by the SRI researchers using the following two *additional* premises:

1) That the *relationship* (confined to those R&D contracts which require one or more major breakthroughs in design) should stimulate a successful two-party business *partnership* wherein *all* bits of information concerning the business (that particular R&D project) of the partnership freely flow between the partners and wherein all bits of information about their domestic affairs flow *not at all.*

2) That the job of re-educating and training a segment of the American industry combine (whose mass-production abilities won two world wars) to understand that "R&D projects requiring breakthroughs are altogether different in character than mass-production work and therefore require a different management philosophy" is a gigantic endeavor and can be likened to changing the running capabilities of a Kentucky race horse to those of a cheetah.

Kenneth K. Knopf
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The Countdown

WASHINGTON

Review of Big Solids Is Set

House Space Committee chairman George Miller will meet with Secretary of Defense Robert McNamara within 10 days to discuss the reported reduction in Fiscal '64 funds for the Air Force's big solid motor program. Miller says that in the event of a DOD reduction in funds, NASA might be given the program. Final decision will come after the committee studies big solids during forthcoming hearings on U.S. space boosters. The committee chairman, who witnessed United Technology Corp.'s successful firing of its 120-in. motor for *Titan III*, believes the nation may be neglecting the potential of big solids.

NASA Funding Delayed for Unanimity

Behind the more than two week delay of the NASA authorization bill by the House Space Committee will be a successful effort to get a unanimous report. This bipartisan support is expected to help the bill through floor debate. One major problem overcome: wording of the committee's policy statement. It now supports a larger military space program.

ASD to Phase Out of Dyna-Soar Project

Air Force's Space Systems Division is expected to take over all *X-20 Dyna-Soar* work from Aeronautical Systems Division. Originally an ASD project all the way, *X-20* now is under ASD for the air-dropped portion and SSD for orbital phases. Within a few months, the entire project is due for a shift to SSD—over strong ASD objections. Big question is whether there will be any project for SSD to take over.

CIA Briefs House on Soviet Space Plans

Central Intelligence Agency has given the House Space Committee a top secret briefing on Russia's space program. CIA discounted as "complete nonsense" Sir Bernard Lovell's report that Soviet scientists believe instruments should be used to explore the Moon and that the Russians would like to cooperate with the U.S. on a lunar landing program. The briefing, which indicated considerable Russian progress in the lunar effort, did not change the committee's position on the NASA budget, however. It formally reported out a $492 million reduction in the Fiscal '64 authorization.

Steps to U.S. Space Station Outlined

Here's how Air Force planners see the sequence of events leading to a manned orbiting space station: (1) Approval of DOD participation in such a program, (2) assignment of AF as DOD's executive agent, (3) activation of a specific project to be called the *National Orbiting Space Station (NOSS)*, (4) assignment of managerial responsibility to AF under the aegis of the *Gemini* Program Planning Board, (5) change of the board's title to Space Program Planning Board, (6) establishment of the board as a permanent joint body of DOD and NASA to administer all major U.S. space programs on a national, rather than single-agency basis.

NASA Restoration May Reach $200 Million

Look for Senate restoration of close to $200 million in the $490 million cut made by the House in the NASA FY 1964 authorization bill. *Apollo* manned spaceflight funds are expected to be totally restored ($120 million plus $28 million for integration and checkout, and $5.7 million space medicine), *Surveyor Orbiter* ($28 million), *Rover* ($5 million), communications satellites ($7 million) and other programs showing "broad technological benefits" will probably be entirely restored. Cuts will remain in construction "comfort" items and some advanced programs. While NASA's re-programming privileges may not be restricted as stiffly as in the House bill, the Senate will demand a closer liaison between Congress and NASA on the agency's re-programming plans. Action on the House and Senate bills is expected some time this week, and the budget will then move into Joint Committee session, where a "split the difference" move is expected.

INDUSTRY

Reorganization Seen at Martin-Baltimore

Rumors persist that another organizational shakeup is in the offing at Martin Co.'s Baltimore facility. A decision is expected soon that will either eliminate the Electronics Products division or go all out with the corporate backing necessary to build a strong operating division. Actually, the division has been operating in the black for some months, according to reports. One factor: departure of Dr. Albert Hall for DOD.

RL-10 Contract Ready for Signing

Signing of a $14.8 million contract with Pratt & Whitney for 49 RL-10 engines was expected last week. Engines will be procured by NASA and then shipped to General Dynamics/Astronautics and Douglas Aircraft Co., where they will be mated with the *Centaur* and *S-IV Saturn* stage.

California Still Leads NASA Contracting

California continues to head the list of states sharing in NASA procurement. Total space agency procurement in the first half of Fiscal 1963 was $1.3 billion. California's share was $371.3 million. Most of this stayed in the state as $207 million was distributed by the prime contractors to first and second tier subcontractors in California. Second and third place in the list of states sharing in NASA contracts went to Missouri with $85.5 million and Louisiana with $73.4 million.

INTERNATIONAL

Sud, SEPR Confirm Space Agreement

Sud Aviation and Societe d'Etudes de Propulsion par Reaction (SEPR) have confirmed conclusion of a cooperative agreement in the missile/space field (COUNTDOWN, June 17, p. 9). Sud owns a substantial amount of stock in SEPR.

Test Ban with Soviets Weighed

The nuclear test ban agreement with the Soviet Union is not expected to have any immediate effect on U.S. antimissile missile programs. Both the Martin Co. and the U.S. Army have issued statements reporting that work on the *Sprint* missile is continuing as planned. Warhead for *Sprint* already has been tested, according to reports.

ALLOY 7039 WELDABLE/HEAT-TREATABLE NEW FROM KAISER ALUMINUM

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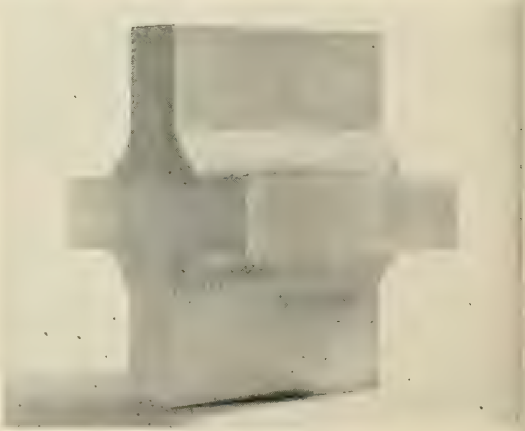

Cruciform weld test for restrained weldments demonstrates Alloy 7039 advantages in weld ductility and weld crack resistance. Results are superior to every other heat-treatable alloy with no requirement for post-weld heat treating.

REPRESENTATIVE TENSILE PROPERTIES—PLATE (at Room Temperature)	Test Direction	7039** -T6⁽¹⁾	2014 -T6	2219 T-87	5083 -H113
TENSILE STRENGTH,	Long.	65	—	68	46
KPSI	Trans.	65	70	69	—
YIELD STRENGTH,	Long.	55	—	57	33
KPSI	Trans.	55	60	57	—
ELONG.—	Long.	13	—	10	16
% IN 2"	Trans.	13	13	10	—
COMPRESSIVE YIELD,	Long.	58	—	57	32
KPSI	Trans.	60	—	60	35
BRINELL HARDNESS		133	135	128	—
NOTCHED TS, KPSI		98	65	—	60
NTS/UNTS		1.35-1.5	0.93	—	1.26

(1) 0.25 to 2.0-inch gauges.
**An experimental temper not yet available commercially shows tensile properties 5 to 10% higher than the -T6 temper.

7039 CHEMICAL COMPOSITION (as registered with the Aluminum Association)	% by Weight
SILICON	0.30 Max.
IRON	0.40 Max.
COPPER	0.10 Max.
MANGANESE	0.10-0.40
MAGNESIUM	2.3 -3.3
CHROMIUM	0.15-0.25
ZINC	3.5 -4.5
TITANIUM	0.10 Max.
OTHERS, EACH	0.05 Max.
OTHERS, TOTAL	0.15 Max.

REPRESENTATIVE AS WELDED TENSILE PROPERTIES OF BUTT WELDS IN PLATE*	7039-T6/ X 5039**	2219/ 2319**	2014/ 5356**	5083/ 5183**
TENSILE STRENGTH, KPSI	54	37	40	43
APPARENT YIELD STRENGTH, KPSI	32	19.5	28	21
ELONGATION % IN 2"	11	4.3	3.2	16

*These properties have been obtained in weldments tested with bead removed. **Weld Filler.

PHYSICAL PROPERTIES	7039	2014	2219	5083
SPECIFIC GRAVITY	2.74	2.80	2.83	2.66
DENSITY, LBS. PER CU. IN.	0.0988	0.101	0.102	0.096
ELECTRICAL CONDUCTIVITY, % IACS	35	50	44	29

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Experience with large scale digital computers and data reduction techniques. Knowledge of curve fitting techniques, probability and vector and matrix analysis is necessary. Knowledge of inertial guidance systems and error sources desirable.

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COMPUTER SYSTEM ENGINEERS

Experience with theory and design of programmable aerospace general purpose guidance computers.

Will define the requirements, conduct design reviews, determine acceptance test criteria, and work on or lead the design improvements and develop new methods for using computers.

SYSTEM OPERATION ANALYSTS

Experience in total weapons systems and the application of inertial guidance to these systems.

Will determine guidance system operational requirements from the standpoint of the overall weapons system or space vehicle. Will anticipate mission problems related to the guidance/navigation system and recommend solutions.

SYSTEM ANALYSIS ENGINEERS

Experience in guidance and control analysis, control system optimization, error analysis and error propagation for internal guidance systems, servo analysis, trajectory analysis, or a combination thereof. Knowledge of advanced calculus, vector analysis, classical mechanics, Bode diagrams, root locus plots and LaPlace transforms highly desirable.

Will analyze error sources in inertial guidance systems and their contribution to systems performance. Will conduct servo analysis and solve trajectory problems using analog/digital computers. Will construct mathematical models.

SYSTEM DESIGN ENGINEERS

Experience in guidance and control system design, configuration analysis, system test or evaluation, circuit theory, optical and inertial sensors and servo theory.

Will examine the state-of-the-art for broad application of inertial electrical-optical, and manually operated optical sensors for navigation and control of manned and unmanned spacecraft. Will conduct preliminary design studies of navigation and control techniques for advanced manned and unmanned spacecraft.

SYSTEM INTEGRATION ENGINEERS

Experience in integrating the various components of an inertial guidance system and integration of the guidance system into the vehicle. Knowledge of inertial navigation, gyros and accelerometers is required.

Will integrate components into the inertial guidance system and the system into vehicle, and solve problems of interface, such as grounding, signal isolation, and hardware and digital computer interface.

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UTC Test Fires Titan III Booster

COYOTE, CALIF.—The successful test firing, July 20, of the first 5-segment, 120-in. prototype solid booster for the Air Force's *Titan III-C* vehicle puts United Technology Center slightly ahead of schedule on the first major incentive-type propulsion systems contract.

The United Aircraft Corp. division designed, built and fired the massive booster within a year of the original contract and less than 9 months from the initial hardware definition phase.

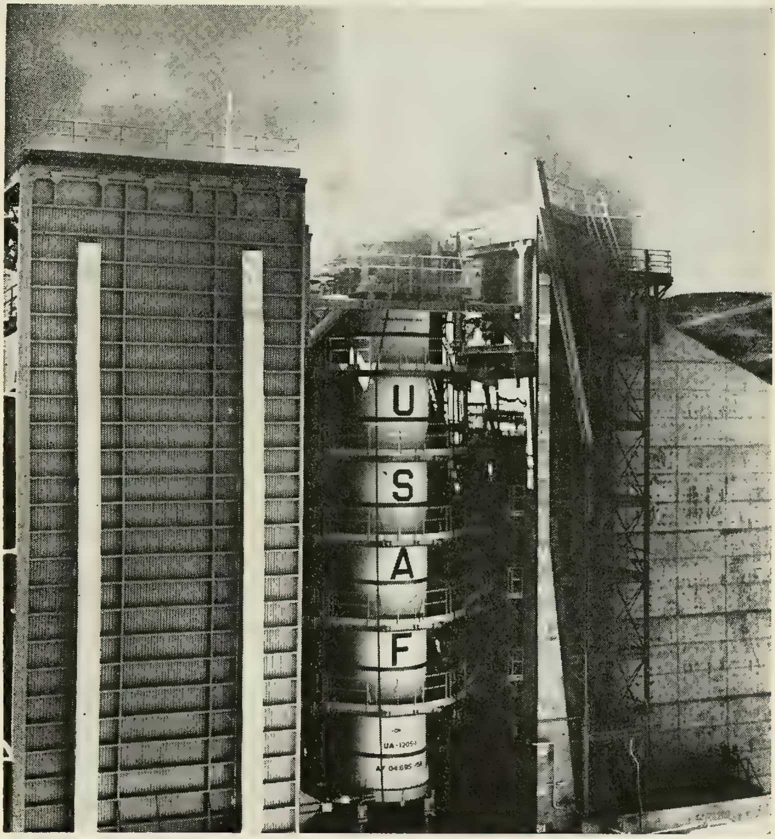
The latest firing had its beginings with the Air Force-funded development program in big solids starting with the 100-in. program at Aerojet-General and other research efforts at Lockheed Propulsion and UTC—and may serve to rescue the dollar-starved 260-in. solid feasibility study.

While exact figures are classified and most of the data from the firing is not yet available, the 120-in. prototype generated over one million lbs. of thrust for slightly more than 110 seconds. The actual firing time was within 0.2 seconds of that programmed—demonstrating the ability of the boosters to perform well within the 2% deviation allowable in the *Titan-III-C* dual-motor vehicle.

The test motor was fired nose-down in UTC's massive stand, using a train-type ignition system involving a series of small rocket motors. A nitrogen-tetroxide thrust-vector-control system was included in the test. Airborne hydraulics and ground-based electrical power were used.

The motor was poured in segments and mated through the UTC pin-and-clevis joint system. There is a gap between each segmented grain section in the final assembly, with the facings inhibited and the joint area heavily insulated.

The test nozzle came from H.I. Thompson Fiber Glass Co., supplier of nozzles for the *Titan III-C* booster together with Tapco Division of Thompson Ramo Wooldridge. The motor case used in the test was designed and work initiated on it before the program definition phase had been completed—a major factor in achieving such an early test date.



The largest solid booster ever fired performed perfectly in UTC's 4-million-lb. thrust stand. The 75-ft.-tall rocket weighs 250 tons and the 11-ft.-long nozzle has an exit cone diameter of more than 9 ft. Six-degree cant of nozzle is discernible. Load cells, at base of test stand and near the aft closure, measured thrust and vector control.

As a result, it differs slightly from the flying hardware to be provided by both Westinghouse Electric and Curtiss-Wright Corp. All future cases will come from one or the other of these two firms.

Although the UTC firing exceeded expectations, Brig. Gen. Joseph S. Bleymaier, System Director for Air Force Program 624A (*Titan III*), told M/R there are no plans to either advance the flight schedule or shorten the test program—even if all other components in the system perform as well. The main roadblock to any such program shortcut lies in the construction of the integrate-transfer-launch (ITL) facility at Cape Canaveral. This facility is part of the *Titan-III* system.

Only one mission is currently slated for the *Titan III-C* vehicle—the *X-20 Dynasoar* program—but the launch vehicle has a wide range of capabilities, in the 5,000 to 25,000-lb. payload range. The vehicle can boost 5,000 lbs. to escape speeds.

The total cost of the *Titan III* development program is estimated at $745 million through completion and testing of 17 vehicles in the 45-month schedule.

- **Associate contractors**—The *Titan III-C* core consists of a modified *Titan II* powered by Aerojet-General storable-fuel engines and an Aerojet transtage upper stage. A.C. Spar Plug Div. of General Motors wi provide the guidance and Ralph M Parsons Co., the architecture an engineering.

Martin-Marietta Corp. handle the airframe assembly, test and system integration; UTC, the soli boosters and operation of the Edwards Air Force Base test comple

There is no single prime contractor in Program 624A. The Spac Systems Division of the Air Forc Systems Command, under Major Ger Ben. I. Funk, is the executive manager of the program. SSD contracte with Aerospace Corp. for system engineering and technical directio

Major Contractors for 120-in. Firing

- **Nozzle**—H.I. Thompson Fiber Glass Co. supplied the nozzle assembly consisting of a steel outer shell with reinforced plastic insulation and a graphite liner. The exit cone was reinforced with tape-wound, phenolic-impregnated silica backed up with an aluminum honeycomb faced with stainless steel. The two-section nozzle used more than 5,000 lbs. of glass.
- **Insulation**—The forward and aft closures were insulated by H.I. Thompson Fiber Glass Co. Segments were insulated with synthetic rubber liners provided by Rohr Corp. to specification and bonded in place by UTC.
- **Motor Case**—All segments were provided by Allis-Chalmers under a $1.6 million contract from Pratt & Whitney, division of United Aircraft Corp. The H-11 tool steel segments were fabricated from vacuum degassed stock to a thickness of 0.360 in.
- **Other subcontractors**—Vidar Corp. for the 318-channel data acquisition system; Dow Chemical Co. for its D.E.R. 332 epoxy resin and Valley Metallurgical Processing Co. for the aluminum powder, both ingredients of the UTC-formulated propellant; Presray Corp. for the 120-in. handling device; Potter Aeronautical for flow measuring equipment; Holz Rubber for igniter insulation; Verson Allsteel Press Co. for the test stand skirt and heat shield and Stearns-Roger Corp., architecture and engineering on the TVC system.

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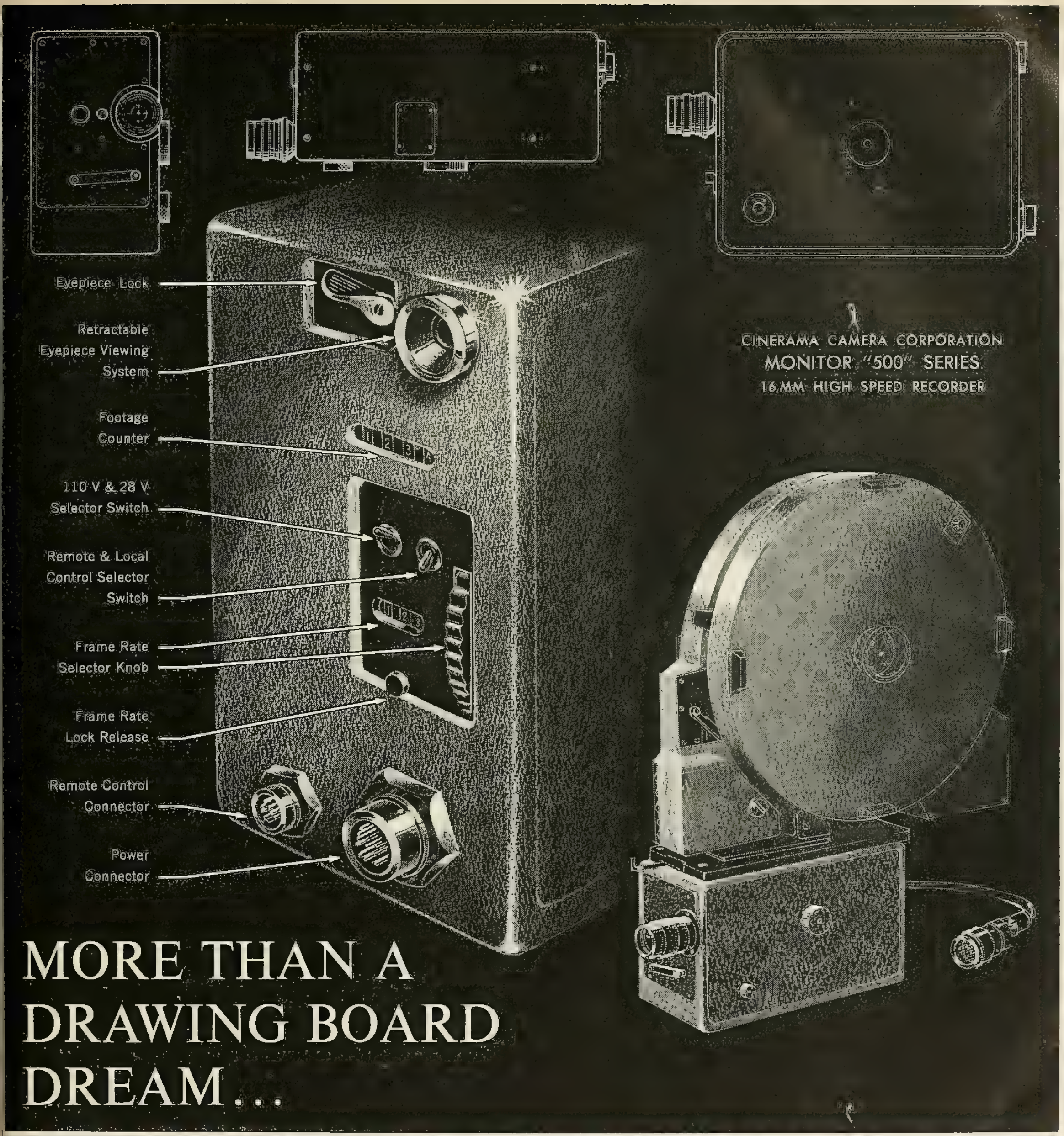
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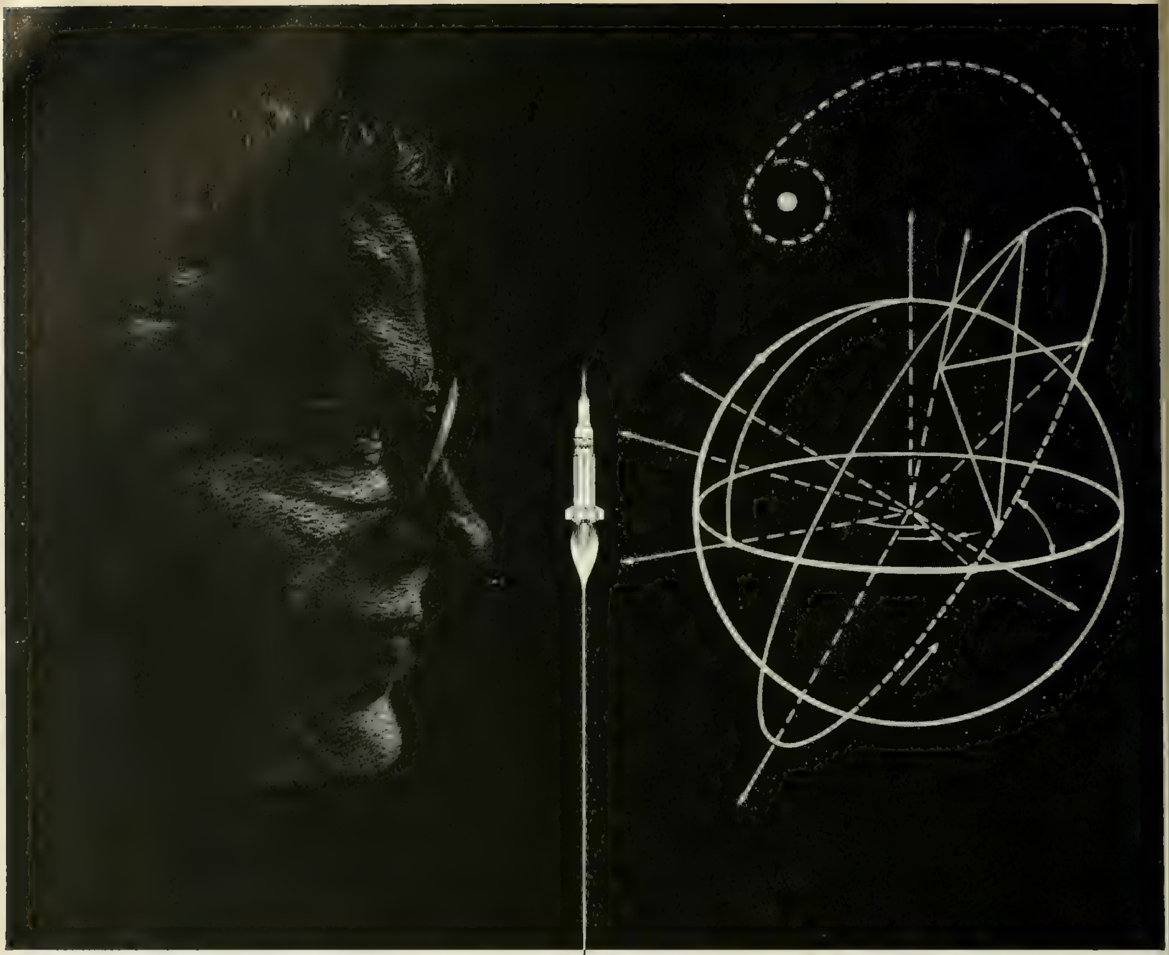

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Transtage Debut Successful

SACRAMENTO, CALIF.—First firing of Aerojet-General Corp.'s *Titan III* Transtage engine in its twin-chamber configuration was judged a success, though one start was halted by false trouble indication and the final run was terminated early to avoid an over-temperature problem.

Three successful starts were made after the abortive first attempt, and the engine ran for a total of 284 sec. before a sensor an inch below the injector flange showed a temperature trend rising rapidly toward the 400°F limit set for the test.

Data reduction was not complete, but there may have been a failure in the injector, which had accumulated nearly an hour of burn-time on previous development firings. The full-duration burn-time planned for Transtage engines is 480 sec.

First flight for Transtage is scheduled in September, 1964. Aerojet will deliver 17 complete propulsion systems for flight, plus several for ground test. The program is in its eighth month and on schedule.

Transtage burns pressure-fed nitrogen tetroxide and A-50, an equal mixture of hyrdazine and UDMH. The chamber is ablatively cooled and the nozzle skirt is very thin, radiation-cooled stainless steel. The skirt is not attached for sea-level tests, because in the atmosphere it would collapse.

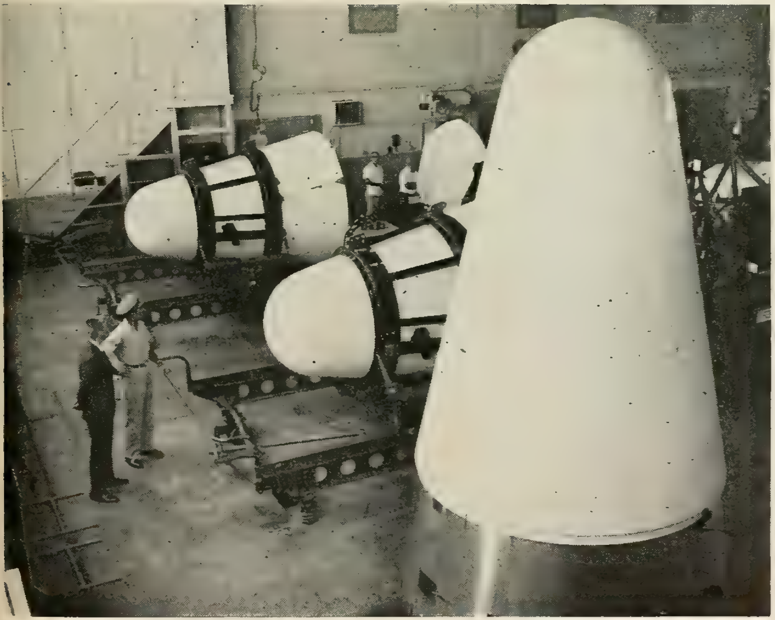
The center of rotation for the chamber gimbals is at the nozzle throat rather than in front of the injector as in most engines. This is to save space in the densely equipped airframe. The gimbals have a new type of bearing developed by Bendix Corp. in which metal-to-metal friction is avoided.

The two chambers in the system are to develop 16,000 lbs. of thrust in space, but there is a degradation of about 40% at sea level. Transtage injectors have fin-like, cruciform baffles regeneratively cooled by fuel.

Mueller Succeeds Holmes

NASA officials declare that new Deputy Associate Administrator for Manned Space Flight, Dr. George Mueller, will have more authority than his predeccessor, Dr. Brainerd Holmes, but it is apparent that the real space czar will continue to be Administrator James E. Webb.

Dr. Hugh L. Dryden, Deputy Ad-



Business End of Titan II

FIRST RELEASED PHOTO of the Mark 6 re-entry vehicles developed by General Electric Co. for the Air Force Titan II ICBM. Maj. Gen. W. Austin Davis, commander of AF Ballistic Systems Div. (right) and Jack L. Norton, manager of flight testing at Cape Canaveral for GE's Re-entry Systems Dept., inspect vehicle in hangar at the Cape. Mark 6 is the largest re-entry vehicle in the U.S. arsenal.

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FUTURE SYSTEMS ANALYSIS

Mission analysis and planning operations research, advanced program planning, human factors.

ELECTRICAL and ELECTRONICS

Create, design and modify complex electrical and electronic assemblies and systems; perform load studies, circuit and system analyses; and logic diagrams of switching networks. **Instrumentation, RF and Telemetry . . .** Missile flight measurements (complete and coordinate instrumentation program, define and document flight measuring instruments), design and develop telemetering and RF equipment, test controls for checkout of flight hardware and digital circuits for guidance and control, operate blockhouse telemetry panels during final countdown, evaluate test results and originate necessary changes.

LAUNCH FACILITIES

Environmental control systems (launch facilities design including air-conditioning systems, cryogenic piping and propellant storage.) Theoretical Launch Facilities Design (feasibility and design studies of future space flight systems, earth orbital and lunar base operations.)

MANUFACTURING

Analyze documentation, determine breakdown of assemblies, define operations, sequence and tool requirements; liaison to control product, process, tool design and inventory. **Special Equipment Design . . .** Development, design, analysis, construction and installation of special equipment; pneumatic and hydraulic, or electronic test equipment; special handling techniques in large components.

PROGRAMMERS

Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

QUALITY CONTROL

Supervise and maintain reference of standards in mechanical systems, electrical systems, quality assurance and systems automation; evaluate instructions and test procedures and develop techniques for adapting digital computers for automatic checkout systems.

RELIABILITY

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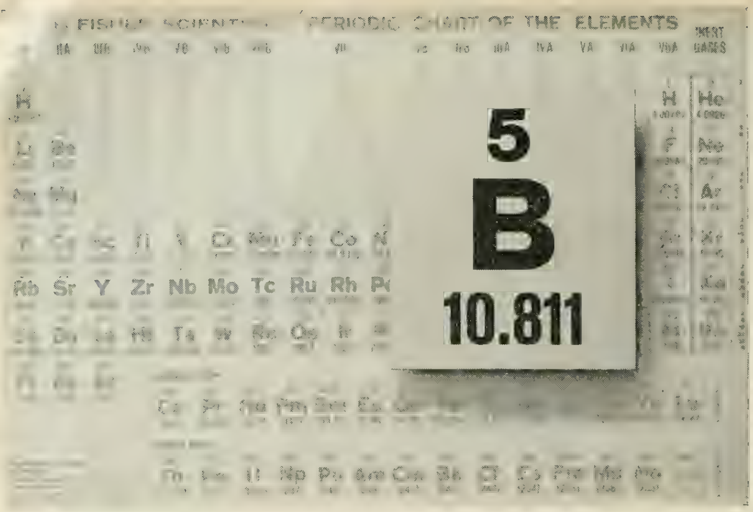

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ministrator, said the added authority stems from a slight change in organizational procedures. The three NASA centers concerned with manned spaceflight will report directly to Mueller on all matters.

Previously, the centers split their reports on budget, personnel, contracting and scheduling between Holmes and Dr. Robert C. Seamanns, Associate Administrator.

Dryden told MISSILES AND ROCKETS, however, that all "policy questions will still have to be referred to top management. When a decision is made, he (Mueller) will be expected to go along with it," the space agency official said.

It was disagreement over policy questions that led to the forced resignation of Holmes.

This makes it clear that Dr. Mueller, currently vice-president of research and development at Space Technology Laboratories, will not be a czar. It is also certain that Project *Apollo* will not be geared to the fastest way to get to the Moon, but rather to Kennedy Administration policy decisions.

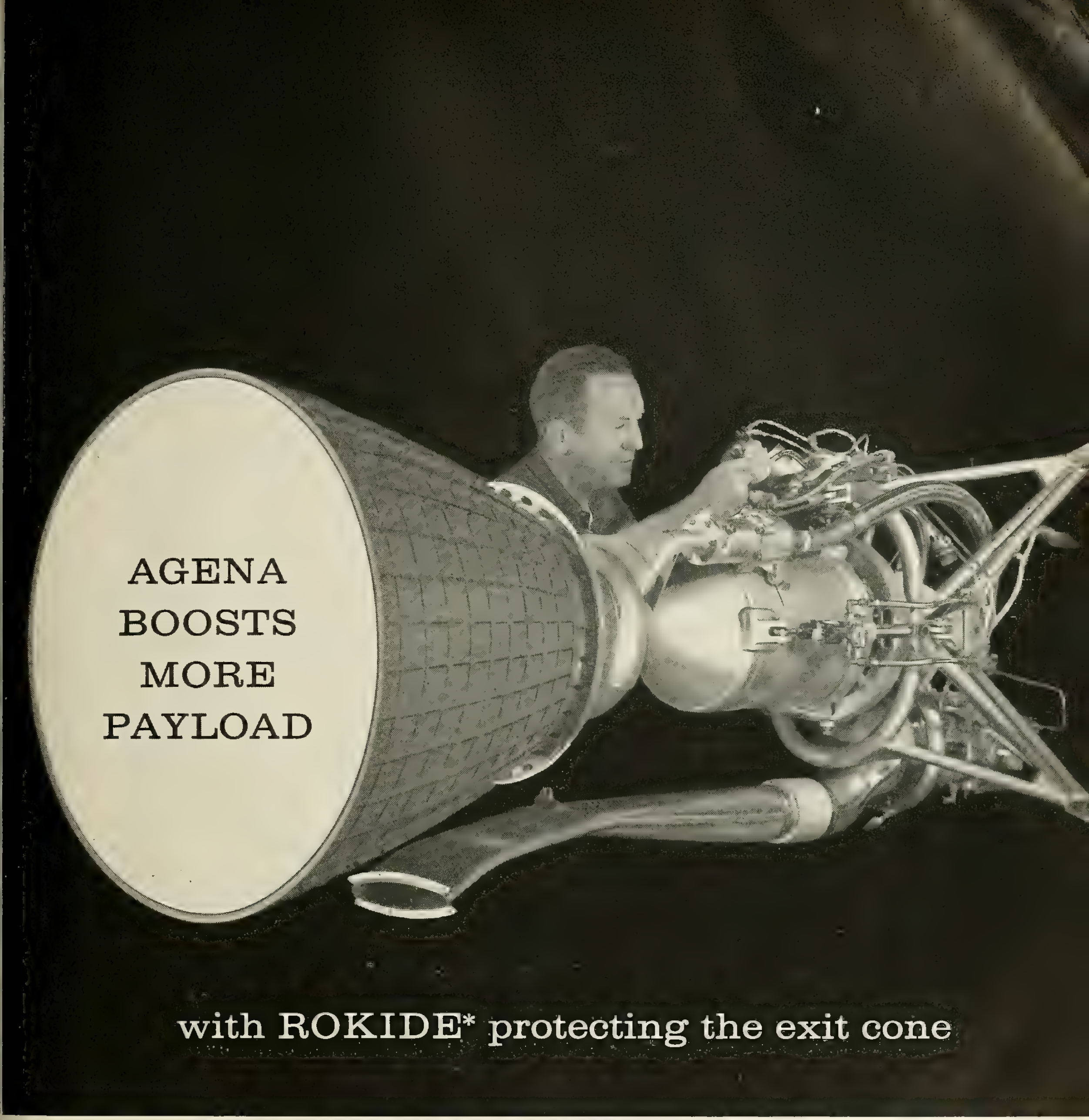
DR. MUELLER

The space agency announced July 23 that Mueller, who has had long years of experience in the management of U.S. ballistic missile programs, will take over his new duties Sept. 1.

The agency said he will have responsibility for NASA's Office of Manned Space Flight and NASA's field centers directly concerned with manned space flight, Marshall Space Flight Center at Huntsville, Manned Spacecraft Center at Houston and Launch Operations Center at Cape Canaveral.

In other comments on recent actions affecting management of Projects *Gemini* and *Apollo*, Dr. Dryden said:

—He thinks it unlikely that Dr.



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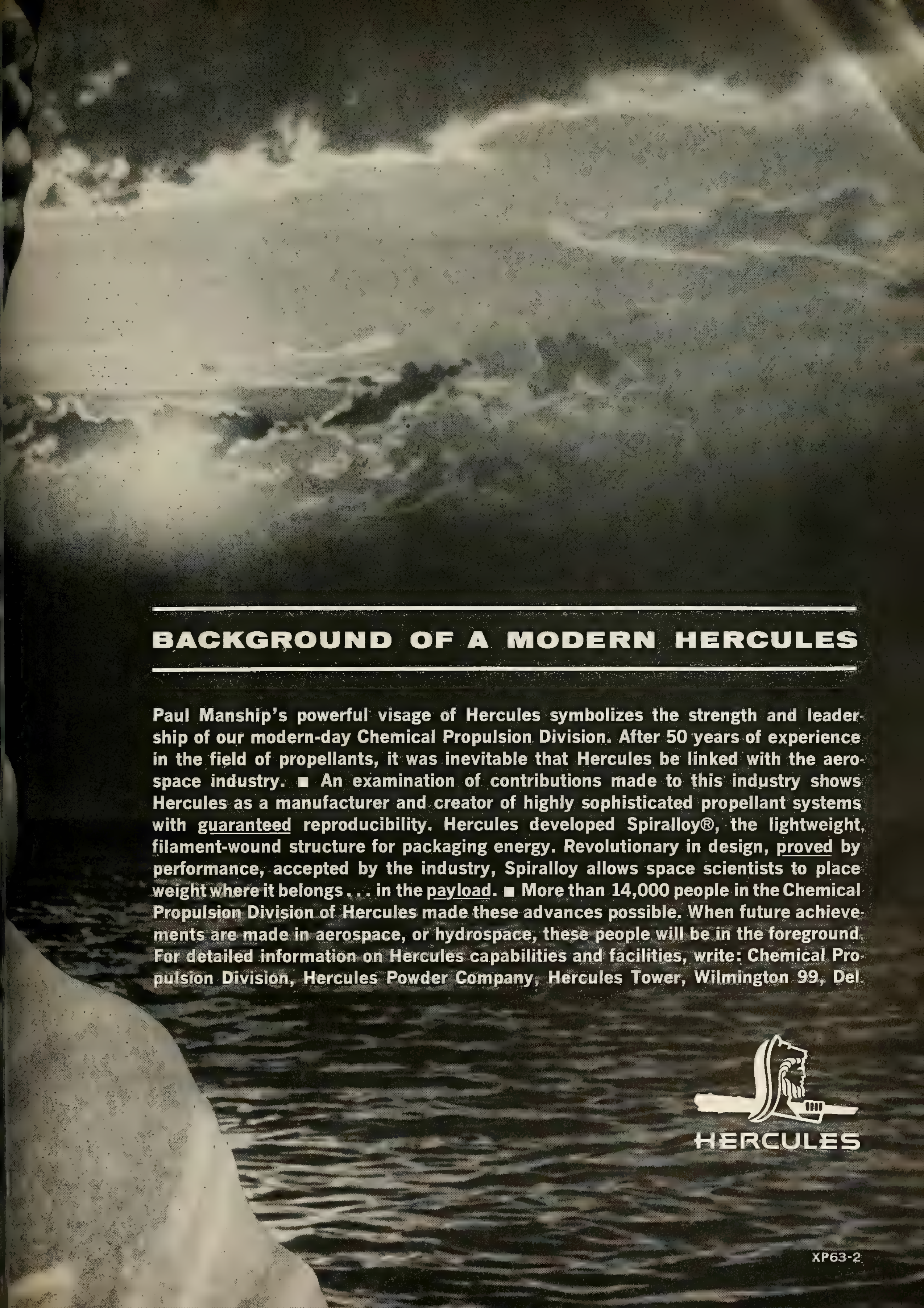

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HERCULES

XP63-2

Mueller will appoint anyone else to fill the position of director of the Office of Manned Space Flight. "It appears that he will wear 'two hats' but the final decision will be left up to him."

—NASA has no plans to hire an industrial contractor to serve as system manager over its current industrial team. The rumor cropped up after the award of a $30,000 contract to STL to study possible changes in the management of the manned space flight program. STL has served as system manager for the *Atlas*, *Titan* and *Minuteman*.

Dr. Mueller, 45, is a graduate of the Missouri School of Mines with a B.S. degree in electrical engineering. He received a PhD in physics from Ohio State University.

At STL, Dr. Mueller has been successively director of the electronics laboratories, program director of the early "Able" space program, and vice president and associate director of the Research and Development Division, vice president of the Space Systems program management and for the last year vice president for research and development.

He has had overall responsibility for the design, development, and testing of systems and components basic to U.S. ballistic missile programs and the development of the United States' first successful space probe *Pioneer I*, for several other space interplanetary probes, including *Explorer VI* and *Pioneer V*, and for establishment of the first world-wide satellite tracking network—the Span Network.

Eclipse Launches Successful

FORT CHURCHILL, CANADA—Possibly the most complex rocket-launching series ever attempted for scientific purposes was accomplished here as part of an intensive U.S. study of the ionosphere during the July 20 solar eclipse.

Despite the very difficult task of sequentially firing and tracking six *Nike-Apaches*, one *Black Brant* and one *Aerobee 150* at specific times based on the phase of the eclipsed Sun (and the intrusion by a bush pilot of the range-restricted corridor just before the third launching), all rockets were fired almost exactly as planned. Air Force and NASA officials declared the research effort at least 70% successful in collecting scientific data.

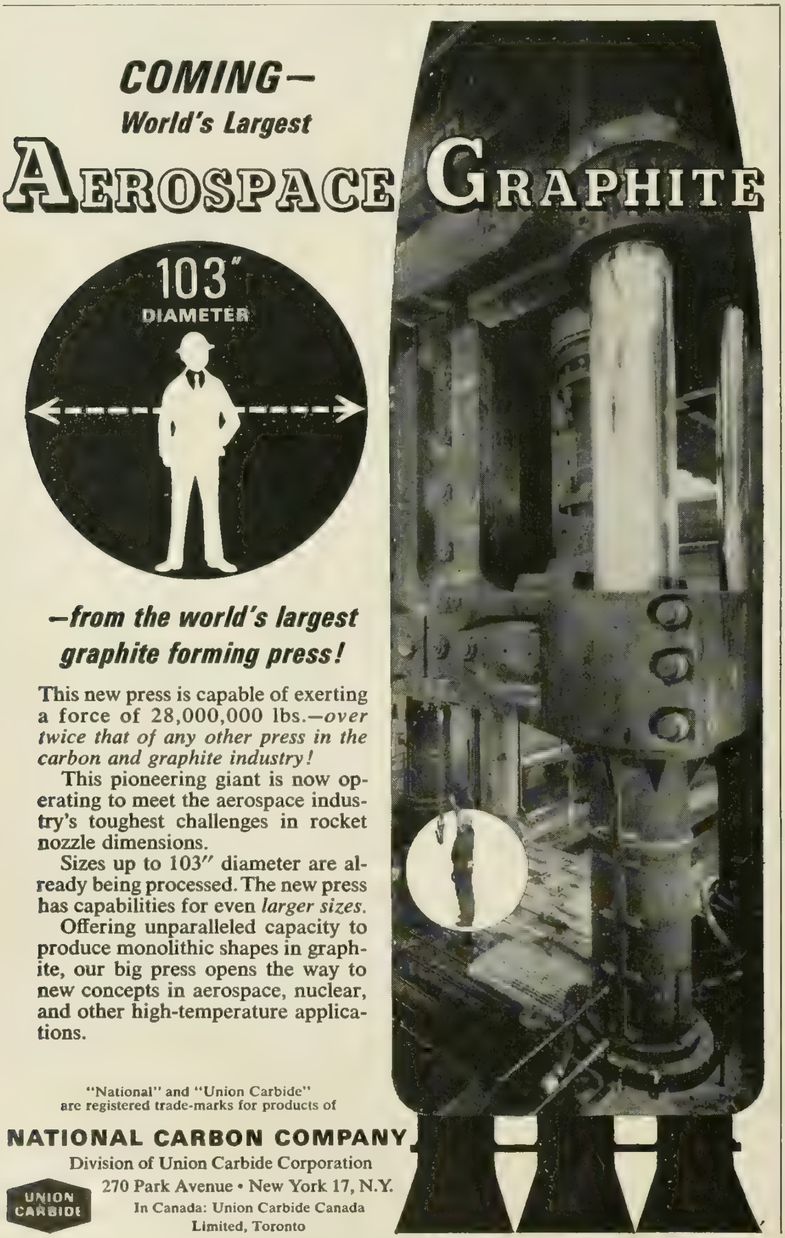
The project, called Operation Probe High, was designed to study the effects of the solar eclipse on electron density in the D-, E-, and F-regions of the ionosphere from start of decay through maximum decay and then recovery.

Beginning at 4:00 p.m. EDT (2000Z), the launch schedule was as follows: *Nike-Apaches* at 4:00, 4:30, and 5:03; *Black Brant* at 5:05; *Aerobee 150* at 5:06; and the remaining *Nike-Apaches* at 5:13, 5:40 and 6:10. The *Apaches* were fired at a nominal azimuth of 110 degrees, the others at 145 degrees.

Although successful first-stage ignition of all eight rockets was accomplished without countdown holds, post-launch problems developed in three vehicles. No useful telemetry was obtained from the first two vehicles (both *Nike-Apaches*), and the *Aerobee 150* failed to reach scheduled altitude.

Scientists from NASA's Goddard Space Flight Center and the Air Force Cambridge Research Laboratories said shortly after the multiple launchings that preliminary quick-look information indicates the collected data confirms previous theoretical predictions of the composition of the ionosphere.

Experimental instrumentation in the various rockets was designed by



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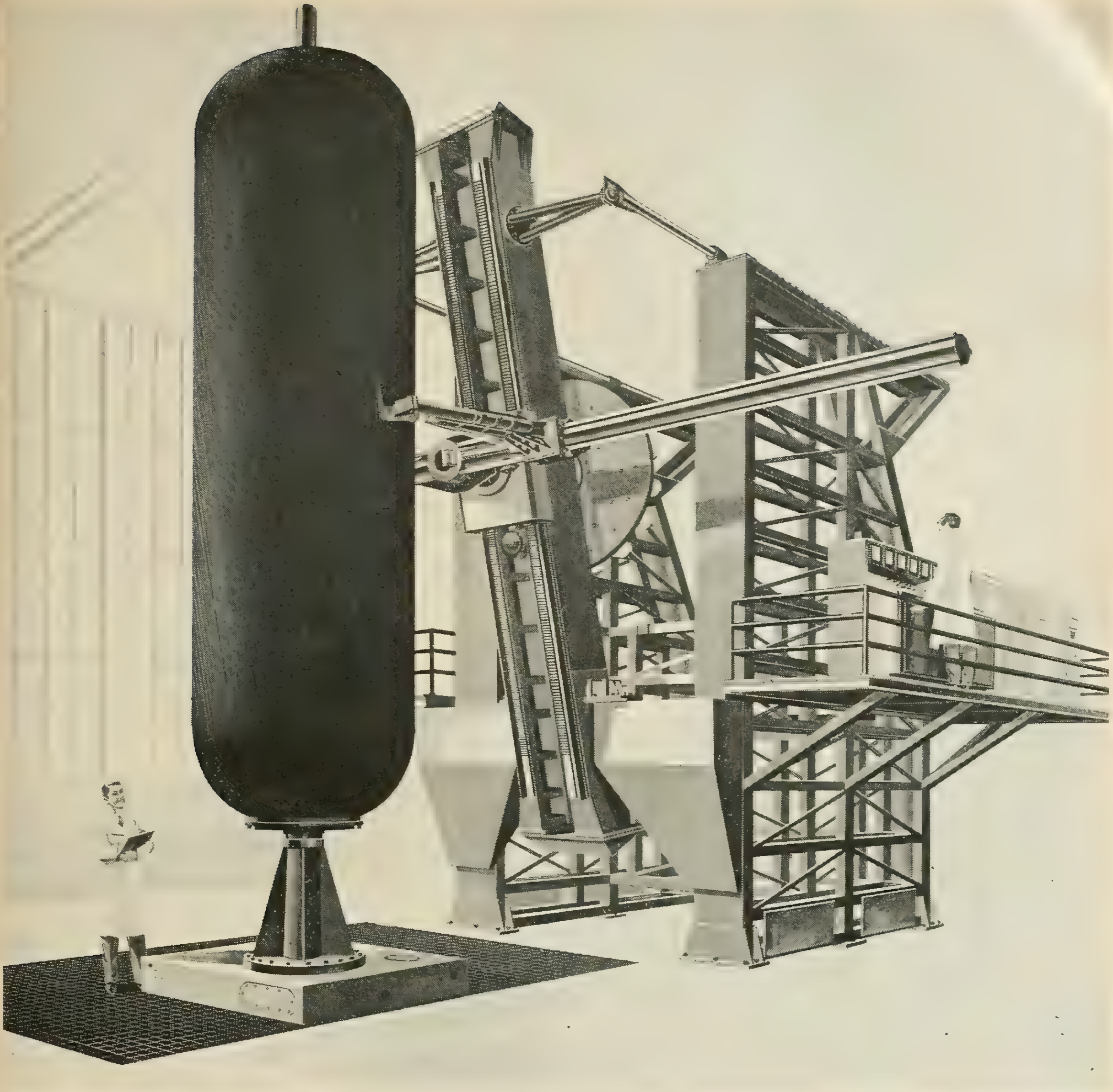

NEW B.F.GOODRICH FILAMENT WINDING FACILITIES PRODUCE GIANT STRUCTURES

Extending its capability for producing filament-wound rocket motor chambers and other products, B.F.Goodrich has opened new facilities for even larger structures. Highlight of the new plant is the special winding machine (see picture) which can wind chambers up to maximum sizes for land transport.

This machine is designed to produce polar, helical, geodesic and circumferential winds—or any pattern that can be identified mathematically. Through a data track system, computer-developed winding patterns can be produced with extreme accuracy, under completely controlled environmental conditions. Included in the new facilities are winding machines for smaller structures, and large presses for molding rubber and plastic insulators. All associated materials control, curing, finishing, inspection, and testing are likewise provided in the new plant.

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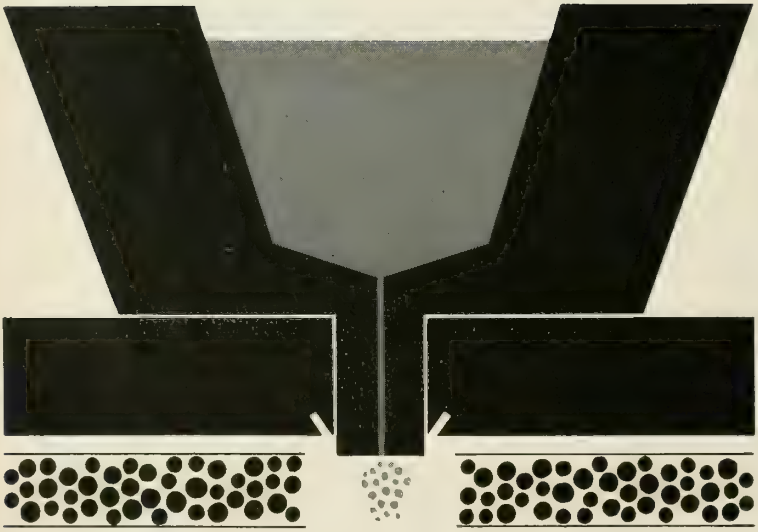

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the two government agencies—the Canadian *Black Brant* carried an AFCRL package; the other seven were NASA vehicles.

The Churchill Research Range, a facility of the USAF Office of Aerospace Research, is located at the Canadian Army's subarctic development and training center on Hudson Bay. The range is operated for OAR by Pan American World Airways and is directed by Col. Jerry Flicek, USAF.

Recently reactivated following a disastrous fire in 1961, the range provides a unique facility for upper-atmosphere rocket research. It is located in a portion of the Earth which is exposed to 100% of the annual northern auroral displays.

During the recent solar eclipse, Churchill was in a zone that experienced over 90% coverage of the solar disk.

NASA Buying Rises 108%

NASA's procurement in the first six months of Fiscal '63 totaled $1.3 billion, up 108% or $677 million compared to the first half of Fiscal '62.

In the same period, the space agency reported, contractor profit on cost plus fixed fee awards remained at about 6 to 7%, industry's share of direct awards from NASA increased from 52 to 63%, the use of competitive bid procedures increased by 3%, small business's share of NASA procurement dropped by 3%, and as expected, North American Aviation Inc. and McDonnell Aircraft Corp. were first and second, respectively, in the list of NASA contractors.

The agency also said that 32 large firms reported that of the $583 million which they received in NASA contracts, almost 50% or $251 million was subcontracted to other firms.

Of the $1.3 billion procurement total, $826.1 million went directly to business.

Contracts received by other organizations included educational and non-profit, $35.3 million; Jet Propulsion Laboratory, $146.8 million; government agencies, $297 million; and outside U.S., $2.1 million.

In addition, contracting between the other organizations and industrial firms brought industry's share in NASA procurement to almost $1.2 billion, or 93% of the total.

NASA placed approximately $72 million with small business firms. This was $32 million or 81% more than during the corresponding period of FY 1962. These purchases and contracts with small business represent 48,000 actions, 38% more than

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AMBIENT TEMPERATURE RANGE	—65 degrees C to 125 degrees C
DIELECTRIC STRENGTH	1000 volts rms; 500 volts rms between open contacts and between coil and housing
INSULATION RESISTANCE	1000 megohms minimum
CONTACT ARRANGEMENTS	1 or 2 pole, double throw
CONTACT RESISTANCE	0.05 ohm initial, 0.10 ohm after rated life
CONTACT RATING	2 amperes resistive (4 amperes overload) and dry circuit
VIBRATION	30 g's from 5 to 3000 cps
SHOCK	150 g's for 11 milliseconds
LATCH TIME (MAXIMUM)	3 milliseconds
RESET TIME (MAXIMUM)	3 milliseconds
COIL RESISTANCE (BOTH COILS)	1000 ohms ± 10% (26-volt dc coil)

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during the first six months of FY 1962.

Of the total awards to business, small business firms received 9% of the dollars during the first half of FY 1963 as compared to 12% during the corresponding period of FY 1962 in terms of the number of actions.

Small business was given opportunity to bid on 21% of the dollar value of NASA's procurements during the first six months of FY 1963. This was only two percentage points less than in the corresponding period of FY 1962. However, small business submitted bids on only 52% of the dollar value of the solicitations in the first half of FY 1963 against 66% percent in the first half of FY 1962.

The top 25 NASA contractors: (thousands of dollars) North American Aviation, Inc., $197,400; McDonnell Aircraft Corp., $84,577; Aerojet-General Corp., $44,776; General Dynamics Corp., $41,652; Chrysler Corp., $32,805; Boeing Co., $31,536; Douglas Aircraft Co., Inc., $30,963; United Aircraft Corp., $26,324; Radio Corporation of America, $18,870; International Business Machines Corp., $18,377; Grumman Aircraft Engineering Corp., $17,458; Space Technology Laboratories, Inc., $15,130; General Electric Co., $14,342; Mason Rust, $11,987; Bendix Corp., $10,908; Ling-Temco-Vought, Inc., $8,494; Brown Engineering Co., Inc., $8,056; Hughes Aircraft Co., $8,014; Republic Aviation $6,394; Hayes International Corp., $5,727; Lockheed Aircraft Corp., $5,388; Union Carbide Corp., $4,765; General Motors Corp., $4,312; Norair Engineering Corp., $3,367; Roediger Construction, Inc., $3,000.

Shots of the Week

NASA's *X-15* rocket plane carried the space agency's chief test pilot, Joseph Walker, to a new world aircraft altitude record of 350,000 ft. July 19, bettering the old record by more than 35,000 ft. Walker, who also holds the world airplane speed record at 4,104 mph, hit 3,866 mph on the flight. On the same flight, Walker released a 30-in.-dia. balloon, attached to a strain gage in the plane, to record air density in space. Flight was made from Vandenberg AFB, Calif.

Other shots of the week:

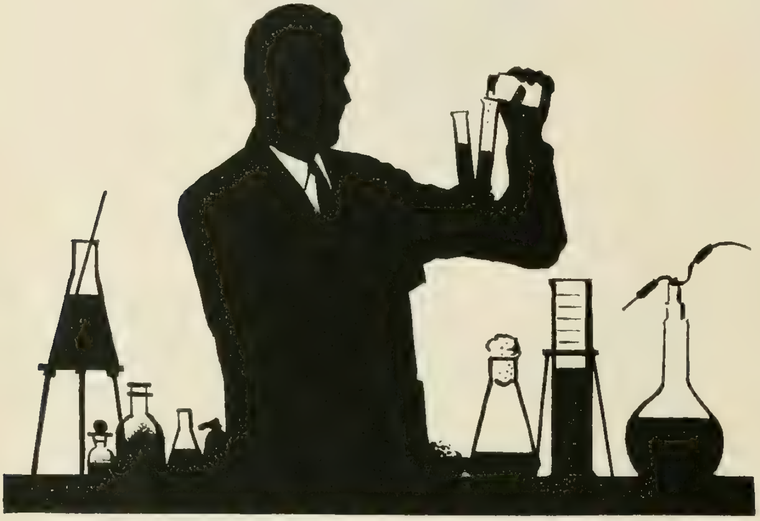
- The Air Force launched two secret satellites July 19 from Pt. Arguello, Calif. The first employed a *Thor-Agena* booster, the second, an *Atlas-Agena*.
- NASA destroyed a *Scout* launch vehicle shortly after liftoff from Wallops Island, Va., July 20. The shot was to have tested re-entry heat shield material for spacecraft use. Cause of the malfunction was not immediately determined.
- A *Polaris A3*, launched July 18 from a land pad at Cape Canaveral, made a successful flight down the Atlantic Missile Range.
- NASA fired an *Aerobee* sounding rocket carrying a 230-lb. instrument package to an altitude of 115 miles July 19. Firing was from Wallops Island, Va.

Syncom Launch Slips

NASA postponed launch of the *Syncom* communications satellite until July 25 after difficulties with the spacecraft's antenna system.

Originally scheduled for July 23, the launch was put off when transducers failed in the second stage of the *Delta* booster. The second delay occurred early in the countdown as NASA scientists prepared the 147-lb. spacecraft.

Earlier, NASA officials announced



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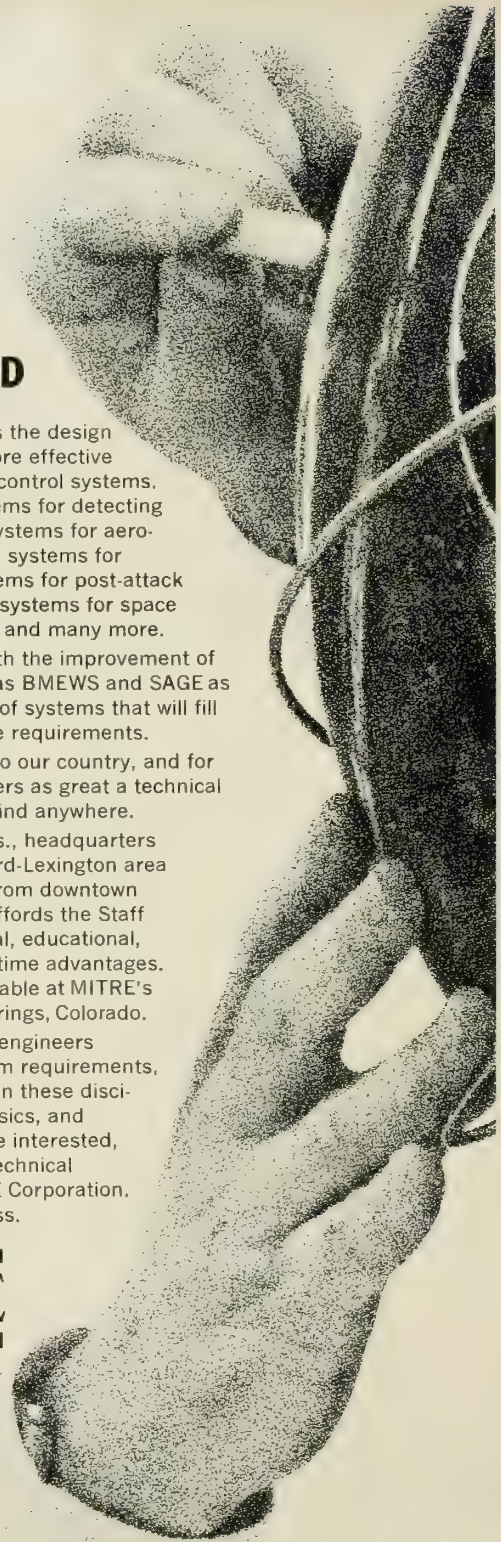

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several changes in the flight plan.

The plan now calls for bringing the satellite on station on a longitude of 55 degrees west about eight days after launch. At that time the satellite's attitude will be reoriented into operating position.

Earlier plans had been to bring the satellite over a longitude of 40 degrees west about 18 days after launch. In the earlier plan, *Syncom* would have been reoriented as it drifted westward to 40 degrees longitude. This would have slowed drift-rate to about 3½ degrees per day.

Under the new plan the drift rate will be about 7½ degrees a day. Communications tests between the USNS Kingsport in Lagos Harbor, Nigeria, and Lakehurst, N.J., will be possible about two to four days after launch rather than the eight days under the earlier plan.

X-20 Still Looks Doomed

Despite the release last week by the Defense Department of $24 million for two more months' development work by Boeing Co. on the *X-20 Dyna-Soar*, Pentagon officials feel Secretary McNamara will cancel the program.

The McNamara *Dyna-Soar* decision is expected within 60 days, and DOD observers think the Secretary's July 12 letter to chairman Richard Russell of the Senate Military Appropriations Subcommittee indicates an *X-20* cutback or cancellation.

In the letter, McNamara asked that a provision in the appropriations bill carry the term "space vehicle" instead of specifically "*Dyna-Soar* or Mach 3 aircraft programs."

This has been interpreted to mean McNamara will divert *X-20* money to an Air Force *Gemini* program.

Indonesia Fires Missile

An anti-destroyer type guided missile has been succesfully fired by the Indonesian Navy. The Navy disclosed the launching July 23, adding that the missile struck a target 15 miles from its launch site.

The shot came on the heels of an announcement that the Indonesian Navy will hold exercises in the waters off Malaya and Borneo in conjunction with its "confrontation" policy against the Malaysian Federation.

Nasser Shows New Rockets

The United Arab Republic unveiled two new missiles last week in Cairo during a parade celebrating

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TAPE COPY STATION FOR ATLANTIC MISSILE RANGE

Six 1.5-mc Mincom CM-100 Recorder/Reproducers form the backbone of an extremely complex tape copy station recently delivered to the Atlantic Missile Range, through Defense Electronics, Inc., Rockville, Maryland. Set up at AMR last March, the station makes possible for the first time as many as five first-generation copies of prime data tapes in one operation. In addition to the six CM-100's, it also includes two 600-kc Mincom G-100's, two degaussers, and an advanced monitor alarm system policing forty-two 1.5-mc channels. The station is the result of Mincom's long experience with frequency responses of better than 1 mc—an outstanding reliability record since 1955.

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the 11th anniversary of the overthrow of King Farouk.

Publicly exhibited for the first time were four new two-stage "Vanguard" rockets and six new long-range antiaircraft rockets, the latter looking markedly like the Russian *SA-2*, which is credited by some with bringing down Gary Power's U-2.

The Vanguard is roughly 30-ft. long, and is reputed to have a range of 360 miles. It appears to be a combination of two shorter-range missiles seen in last year's parade. Announced mission of the missile is space research, but observers are quick to point out its offensive potential (a 360-mile range would put several possible targets, including all of Israel, within striking distance of the Sinai Peninsula).

Missile Designations Detailed

Missiles and drones in the Seventh Annual Missile/Space Encyclopedia are identified by the latest military code numbers. The new Defense Department designations for service-wide use in identifying missiles and drones contain all the elements of former symbols in a standard format.

The designations consist of a status prefix letter (not always included), a launch environment letter, mission letter, vehicle type letter, and the specific vehicle number. Manufacturer's symbols may also be used if several are producing the same missile.

Status prefix symbols are: J—Special test, temporary; N—Special test, permanent; X—Experimental; Y—Prototype; Z—Planning. Launch environment symbols are: A—air; B—multiple (more than one environment possible); C—coffin; H—silo-stored; L—silo-launched; M—mobile; P—soft pad; R—ship; U—underwater.

Mission symbols are: D—decoy; E—special electronic; G—surface attack; I—Intercept, aerial; Q—drone; T—training; U—underwater attack; W—weather. Vehicle type symbols are: M—guided missile (unmanned, self-propelled, controllable course); N—probe; R—rocket (unmanned, self-propelled vehicle without guidance after launch).

Manufacturer's Code Letters are: AJ, Aerojet; AL, Atlantic Research Corp.; AB, Army Ballistic Missile Agency; BH, Beech Aircraft Corp.; BC, Bell Aerosystems Company; BX, Bendix Corporation; BY, Bendix Corporation; BO, Boeing Company; BD, Bridgeport Brass; BP, Bridgeport Brass; BP, Bureau of Naval Weapons; CM, Chrysler Missile Division; CN, Chrysler Space Division; CV, Chance Vought Corporation; DO, Douglas Aircraft Company, Inc.; FA, Fairchild Stratos Corp.; FN, Ford Motor Co. Aeronutronic Division; FS, Firestone Tire & Rubber Co.; CO, General Dynamics/Convair; CP, General Dynamics/Pomona; GP, General Electric; GO, Goodyear Aircraft; GT, Grand Central Aircraft Co.

Also: HU, Hughes Tool Company; HA, Hughes Aircraft Company; KA, Kaman Aircraft Corp.; LD, Lockheed Missile Systems Division; MA, Martin Company; MD, Martin Company; MF, Martin Company; MG, Martin Company; MX, Maxson Electronics Corp.; MC, McDonnell Aircraft Co.; MP, Minneapolis Honeywell; MS, Motorola; NA, North American Aviation, Inc.; NL, Norris Thermator; NV, Northrop Ventura; PP, Philco; RL, Raytheon; RW, Raytheon; RY, Ryan Aeronautical Co.; SU, Sperry Utah Engineering Laboratories; ST, Space Technology Lab.; TH, Thiokol Chemical Corp.; TX, Texas Instrument; WE, Western Electric Company.

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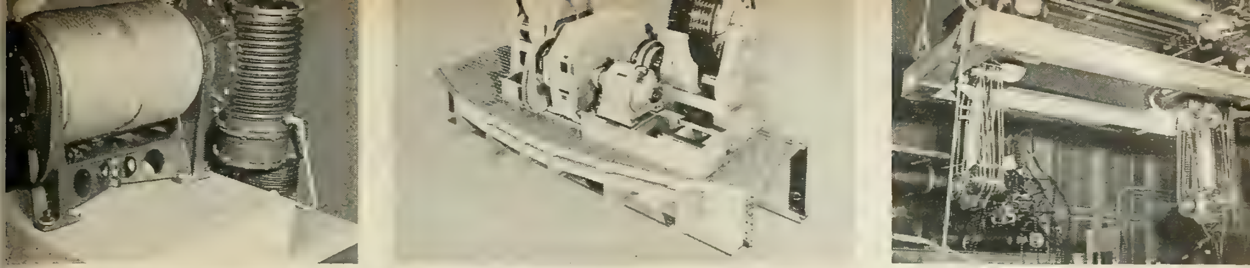
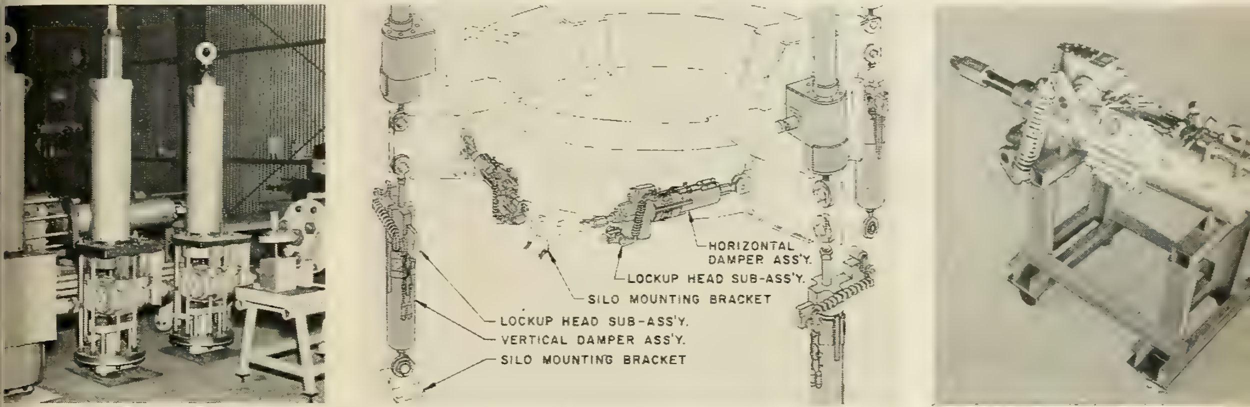
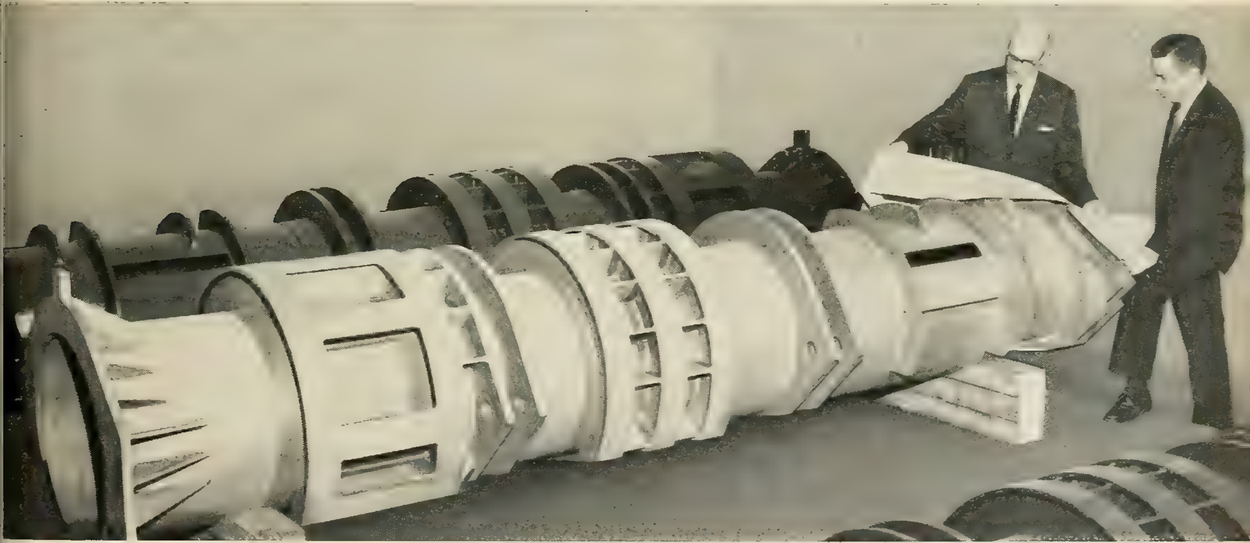


HOISTS–Western supplies these heavy duty hoists for (1) Nike Zeus (2) Atlas and (3) Minuteman missiles.



SHOCK ISOLATION–Vertical and Horizontal damper assemblies of Western's Shock Isolation System for the Titan II.



SPRING CAN ASSEMBLIES–Built by Western as a precision component in the Minuteman missile silo system.

...and now they're calling us the "missile muscle men"

Surprised? This heavy equipment for missile ground handling and positioning is far removed from the lightweight airborne gear drives you probably know us for. You'll want to keep track of how our capabilities keep growing.

For example: Hoists for the Atlas, Minuteman and Nike Zeus. Damper assemblies for the Titan II's in-silo shock isolation system. Spring can assemblies for the Minuteman's silo system.

These are just samples of Western's capabilities in ground handling, missile positioning and shock isolation equipment. Don't they suggest that you call on our "missile muscle men" as a reliable source for this type of gear? Write or call for prompt attention to your newest problems. WESTERN GEAR CORPORATION, Precision Products Division, P.O. Box 192, Lynwood, Calif. Cable address WESTGEAR, Lynwood, Calif.

WESTERN PRECISION PRODUCTS DIVISION

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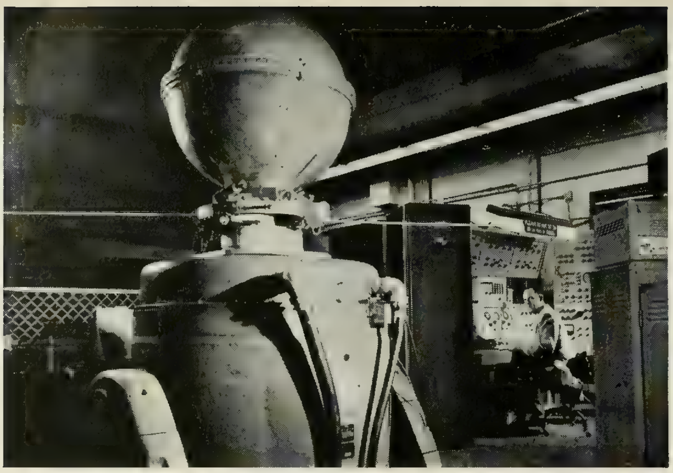

MB Vibration Testing Systems contribute to remarkable record of reliability in space

Have you looked at the record of the U.S. space program lately? It's getting to the point where successful space shots are almost taken for granted.

Considering the preponderous number of variables involved in a satellite launching, this is equipment reliability at its utmost.

MB is proud to have had a part in this remarkable record of reliability. Our highly accurate vibration testing equipment and systems have enabled the design engineer to overcome vibration problems before the final design is accepted.

MB has been a pioneer and leader in the field of vibration testing since 1945. Today, there are more than 4000 MB test systems in use, some for as long as 18 years. This includes 50 of our proven Automatic Equalization Systems introduced in 1960. Highly accurate equalization is accomplished in less than 5 seconds with these 80 channel automatic equalization systems.

The MB line of vibration test equipment includes: electrodynamic exciters, hydraulic shakers, amplifiers and power supplies, automatic controls, and vibration pickups and meters.

Complex Motion Systems

MB's capabilities in the design and application of vibration test systems are now being applied to complex motion simulation systems, such as the unique 6 degree of motion system for the combined astro-medical program of the U.S. Air Force and N.A.S.A.

Our engineers will be glad to consult with you on your vibration testing or motion simulation requirements. Send today for more information on MB's equipment.

MB broadens its line… pulsed X-ray System, strain gage instruments added

MB has embarked upon an extensive program of expansion in the field of environmental testing and measurement. The first of the new products available are a pulsed X-ray system and a line of strain gage instruments.

The MB-Zenith 150 KV pulsed X-ray system takes motion pictures of high speed phenomena occurring within a sealed environment. It is ideal for probing causes of vibration or shock failures, or observing dynamic systems.

Our strain gage instruments combine high accuracy and versatility with economy. The new line includes single and multi-channel instruments for measuring static, dynamic, complex and vibrating strain.

MB ELECTRONICS

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missiles and rockets
seventh annual
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1963
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WORLD MISSILE/SPACE ENCYCLOPEDIA

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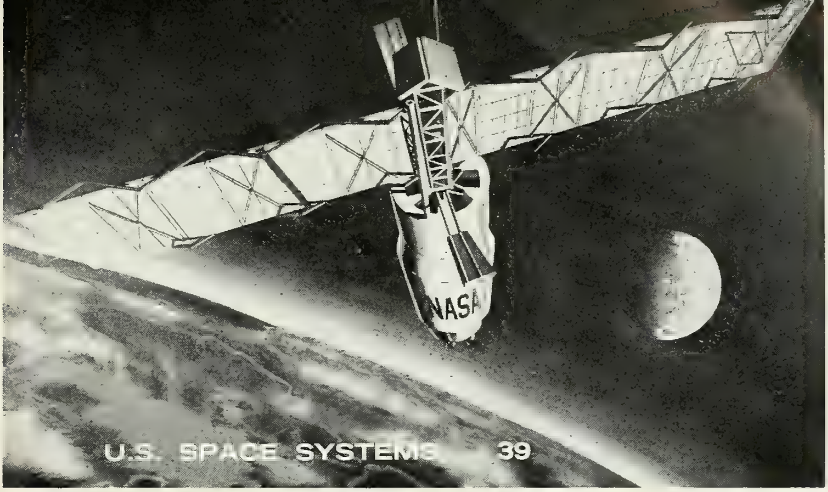
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House power for our moon men will come from an efficient new fuel cell developed by Pratt & Whitney Aircraft for the National Aeronautics and Space Administration's Manned Spacecraft Center. The fuel cell will generate life-sustaining electrical power during the Apollo spacecraft's round-trip voyage to the moon. Pratt & Whitney Aircraft provides design and manufacturing leadership in power for many applications, in and out of this world.

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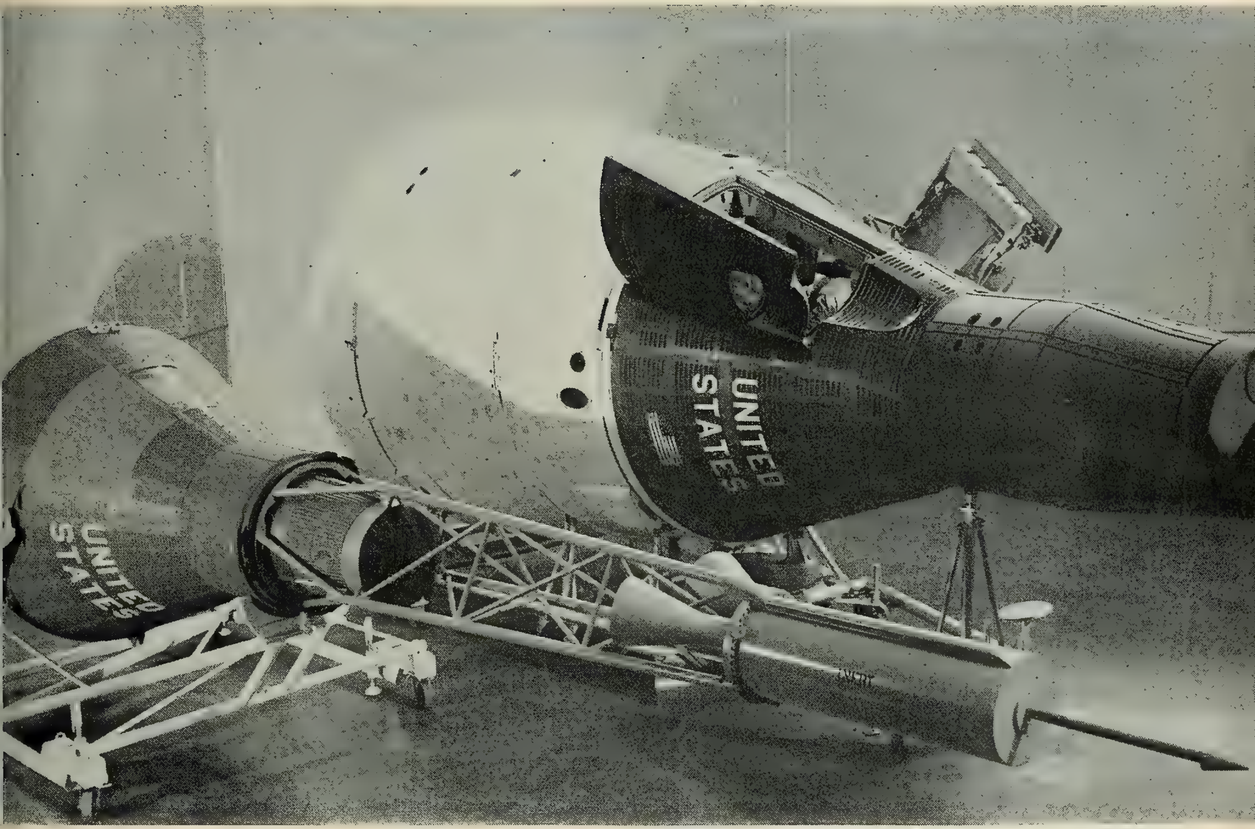


GEMINI (RIGHT) AND MERCURY CAPSULE WITH ESCAPE TOWER

Spacecraft

Apollo Command & Service Module (NASA)

TYPE: Three-man spacecraft

MISSION: Manned lunar landing; ferry vehicle for manned space station

STATUS: R&D

PRIME CONTRACTOR: North American Aviation

GUIDANCE: Astro-inertial with radio inertial backup; systems management, MIT Instrumentation Laboratory; associate contractors, AC Spark Plug, Raytheon Co., Kollsman Instrument Co., Sperry Gyroscope

TELECOMMUNICATIONS: Collins Radio Co.

CONFIGURATION: 3-modular spacecraft; weight 85,000 lbs.; diameter, 13 ft.; command module, 10,000 lbs., 12 ft. high; service, 46,000 lbs., 23 ft. high; lunar excursion vehicle, 25,000 lbs., 20 ft. high

ENVIRONMENTAL SYSTEM: AiResearch Manufacturing Co.

HEAT SHIELD: Avco Corp.

AUXILIARY POWER: Fuel cell, Pratt & Whitney

PROPULSION SYSTEM: Escape motor, Lockheed, solid; reaction control, Marquardt Aircraft; service module propulsion, Aerojet-General, liquid; escape tower, Thiokol Chemical Corp., solid

BOOSTER: Saturn V

REMARKS: First lunar landing expected in 1967-1968; Earth-orbital flights of boilerplate models scheduled for 1965; Test flights of lunar-orbit rendezvous configuration in 1965-1966 using Saturn 1B booster; circumlunar flights 1967; lunar orbit rendezvous will be used; two-man excursion vehicle will detach from Apollo spacecraft in lunar orbit to make Moon landing

Gemini (NASA)

TYPE: Two-man spacecraft

MISSION: Carry two men on orbital flights lasting up to two weeks; test orbital rendezvous feasibility

STATUS: R&D

PRIME CONTRACTOR: McDonnell

HEIGHT: 7 ft.

WEIGHT: Approximately 7,000 lbs.

GUIDANCE: Guidance integration, IBM; rendezvous radar, Westinghouse; spacecraft, all inertial, Minneapolis-Honeywell

PROPULSION: Spacecraft, Rocketdyne

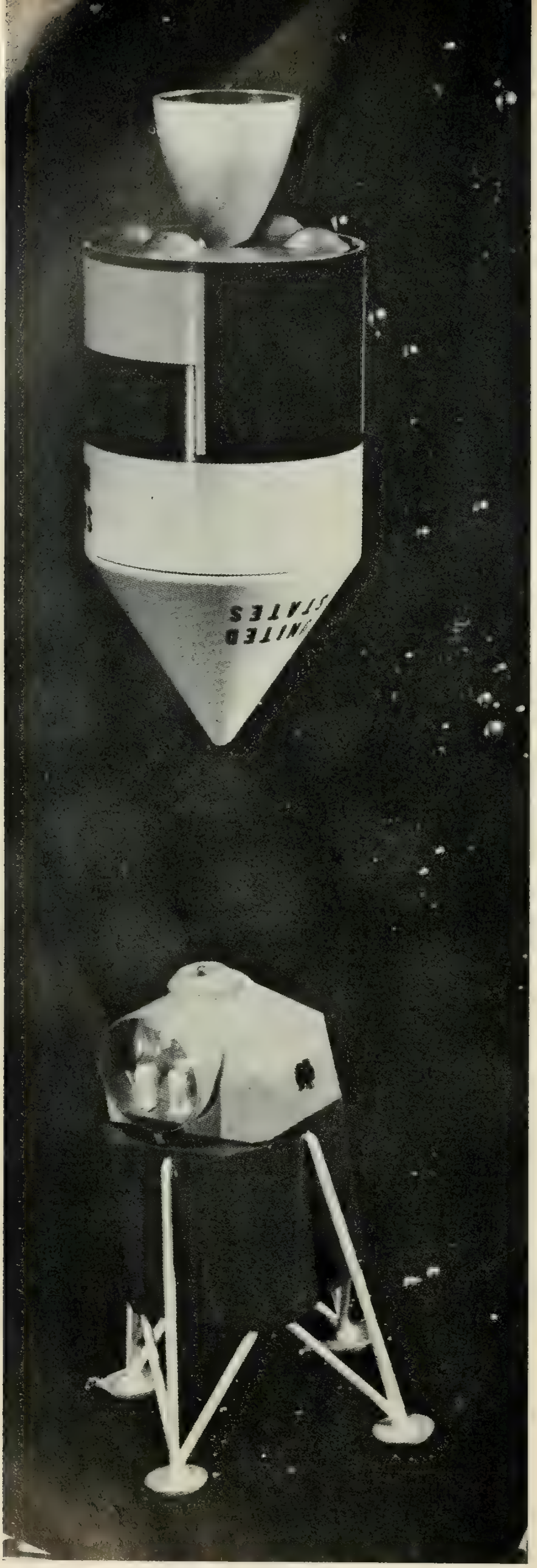
ENVIRONMENT SYSTEM: AiResearch

FUEL CELL: GE

POWER: Batteries and fuel cell

BOOSTER: Titan II; Agena will be used during rendezvous missions; Atlas will launch Agena into orbit

REMARKS: 12 flights scheduled 1964-66—first flight, unmanned orbital—second, unmanned ballistic—third flight being manned flight series in late 1964; all orbital rendezvous flights will be manned



LUNAR EXCURSION MODULE (BOTTOM), APOLLO C & S MODULES

Aerospace Plane (Air Force, NASA)

TYPE: Manned spacecraft capable of Earth-orbit-and-return from conventional airfields without staging

STATUS: Study contracts; component development

PRIME CONTRACTOR: General Dynamics/Astronautics; North American Aviation; Douglas Aircraft—each with a $500,000 study contract

PERFORMANCE: Capable of accelerating to orbital speeds, deorbiting and landing as a conventional aircraft; minimum life of 100 flights reportedly is a requirement of the system

PROPULSION SYSTEM: Resembling a turbo-ramjet design with closeable intake, the engines will operate as turbo-ramjets in the atmosphere, simultaneously gathering, liquifying and storing oxygen for later use; as the atmosphere thins out, the intake is closed, the LOX fed into the engine with liquid hydrogen, and the engines operate as rockets; changeover will reportedly occur about mach 8

REMARKS: Funded by both AF and NASA as a joint research project, system holds most interest for AF as an operational vehicle; AF estimates it could be flying by 1970; NASA funding is for $4 million for FY'64

Lunar Excursion Module (NASA)

TYPE: Two-man spacecraft serving as third module of the Apollo spacecraft

MISSION: Land two men on Moon then rendezvous with orbiting Apollo

STATUS: R&D

PRIME CONTRACTOR: Grumman

WEIGHT:25,000 lbs.

PROPULSION: Lunar descent, Rocketdyne & Space Technology Laboratories; ascent engine, Bell Aerospace Corp.; reaction control, Marquardt Corp.; environmental control, Hamilton Standard; electronic subsystems, RCA

POWER UNITS: Fuel cells

BOOSTER: Saturn V

REMARKS: Eleven flight vehicles and nine engineering models ordered; first three-module Apollo flight scheduled for 1966 with first lunar landing planned for 1968

Lunar Logistics System (NASA)

TYPE: Unmanned spacecraft

MISSION: Land supplies on the Moon in support of Project Apollo or as a logistics carrier in the construction of a lunar base

STATUS: Study

DESCRIPTION: Two possible configurations are under study; modified Lunar Excursion Module (LEM) of the Apollo spacecraft would provide a 7,000-lb. payload capacity; specially developed lunar logistics system weighing 90,000 lbs. would land a 30,000-lb. payload on the Moon

PRIME CONTRACTOR: None; Study contracts by Grumman, STL, & Northrop; more study awards expected

BOOSTER: Advanced Saturn

REMARKS: Program decision delayed until Fiscal 1966 budget discussions

Manned Orbiting Space Station (Air Force, NASA)

TYPE: Large manned spacecraft

MISSION: Provide test bed to determine if man can survive long periods of weightlessness during interplanetary flights; also would permit scientific investigations in space; AF requirements include surveillance, detection and inspection of enemy payloads

STATUS: Under study by Air Force and NASA

PRIME CONTRACTOR: None; NASA study contracts by Boeing, Douglas and Lockheed; AF also expected to award study contracts

REMARKS: Stations being studied include an extended Apollo spacecraft holding two to three astronauts for three months, a manned orbiting research laboratory launched by a Saturn IB holding six men, and a large rotating station which could hold up to 36 persons for periods of one to three years; decision on management of program is expected in late 1963 or early 1964; heavy hardware funding is not expected until Fiscal 1966 at earliest

Mariner (NASA)

TYPE: Unmanned interplanetary spacecraft

MISSION: Scientific exploration flights to the vicinity of Mars and Venus; advanced version also under development

STATUS: R&D

PRIME CONTRACTOR: JPL

CONFIGURATION: Mariner C will weigh 550 lbs.; Mariner B will weigh more than 1,000 lbs.

INSTRUMENTATION: Instruments will change from mission to mission; first Venus Spacecraft, Mariner II, had radiometers, magnetometer, radiation counters and cosmic dust detector; first Mars spacecraft, Mariner C, will have television, magnetometer, radiation counters, and cosmic dust detector

BOOSTER: Atlas-Centaur for Mariner B

REMARKS: Successful Venus fly-by accomplished December 1962; Mars fly-by scheduled for late 1964; first Centaur launched-spacecraft planned for late 1966

Mercury (NASA)

TYPE: First U.S. manned spacecraft

MISSION: Carried one man on Earth-orbital flights

STATUS: Completed

PRIME CONTRACTOR: McDonnell

WEIGHT: 4,000 lbs. plus (including escape tower); 2,000 plus on impact

GUIDANCE: Minneapolis-Honeywell, stabilization system; Bell Aerospace, system manager

AUXILIARY POWER: Batteries

PROPULSION SYSTEM: Escape rockets, solid; retro rockets, solid; control system, liquid

BOOSTER: Atlas D

REMARKS: First U.S. manned suborbital flight May 5, 1961, by Lt. Cmdr. Alan Shepard, USN; 2nd manned suborbital flight July 21, 1961, by Capt. Virgil Grissom, USAF; first U.S. manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC, 3 orbits; 2nd manned orbital flight May 24, 1962, by Lt. Cmdr. Scott Carpenter, USN, 3 orbits; 3rd manned orbital flight Oct. 3, 1962, by Cmdr. Walter Schirra, USN, 6¾ orbits; 4th manned orbital flight May 15-16, 1963, by Maj. Gordon Cooper, USAF, 21¾ orbits; last flight set U.S. record of 37 hrs., 20 min. for manned space-flight

Pioneer (NASA)

TYPE: Unmanned solar probe

MISSION: 120-lb. spin-stabilized spacecraft to obtain information about Sun and solar environment and send data back to Earth at distances up to 90 million miles

STATUS: R&D

PRIME CONTRACTOR: STL

BOOSTER: Delta

REMARKS: Seven flights in program, first flight early 1965

Project Fire (NASA)

TYPE: Re-entry probe

MISSION: Measure environmental heating conditions at lunar-return speeds (25,000 mph)

STATUS: R&D

LAUNCH VEHICLE: Atlas-D, plus Antares II A-5 (re-entry booster)

PRIME CONTRACTORS: Re-entry package, Republic Aviation; velocity package, Chance Vought; launch vehicle and systems integration, General Dynamics/Astronautics

REMARKS: Re-entry package instrumented to define total heating and radiative components of the re-entry environments for manned lunar mission; flights to begin in late 1963

Ranger (NASA)

TYPE: Lunar hard-landing spacecraft

MISSION: 300-lb. instrumented capsule rough-lands on Moon; before impact, TV cameras take pictures of lunar surface

STATUS: R & D

PRIME CONTRACTOR: JPL, prime; Aeronutronic, capsule; Hercules, retro-rockets; Northrop, serving as support contractor, may become prime in 1964

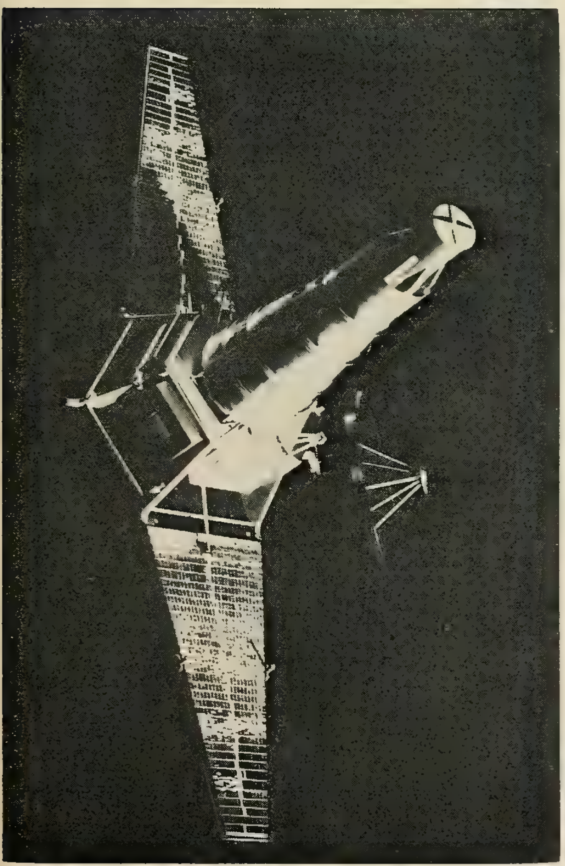
INSTRUMENTATION: TV cameras, seismometer

POWER UNITS: Solar cells

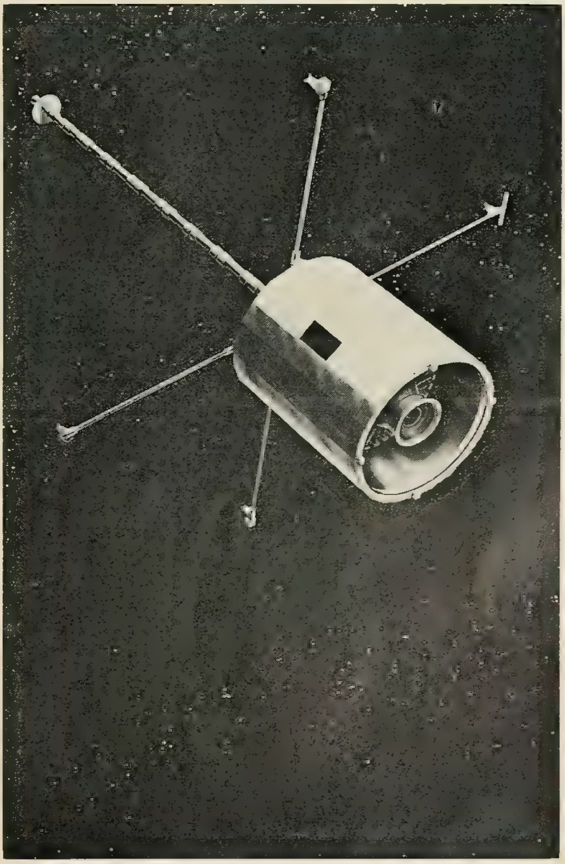
BOOSTER: Atlas-Agena

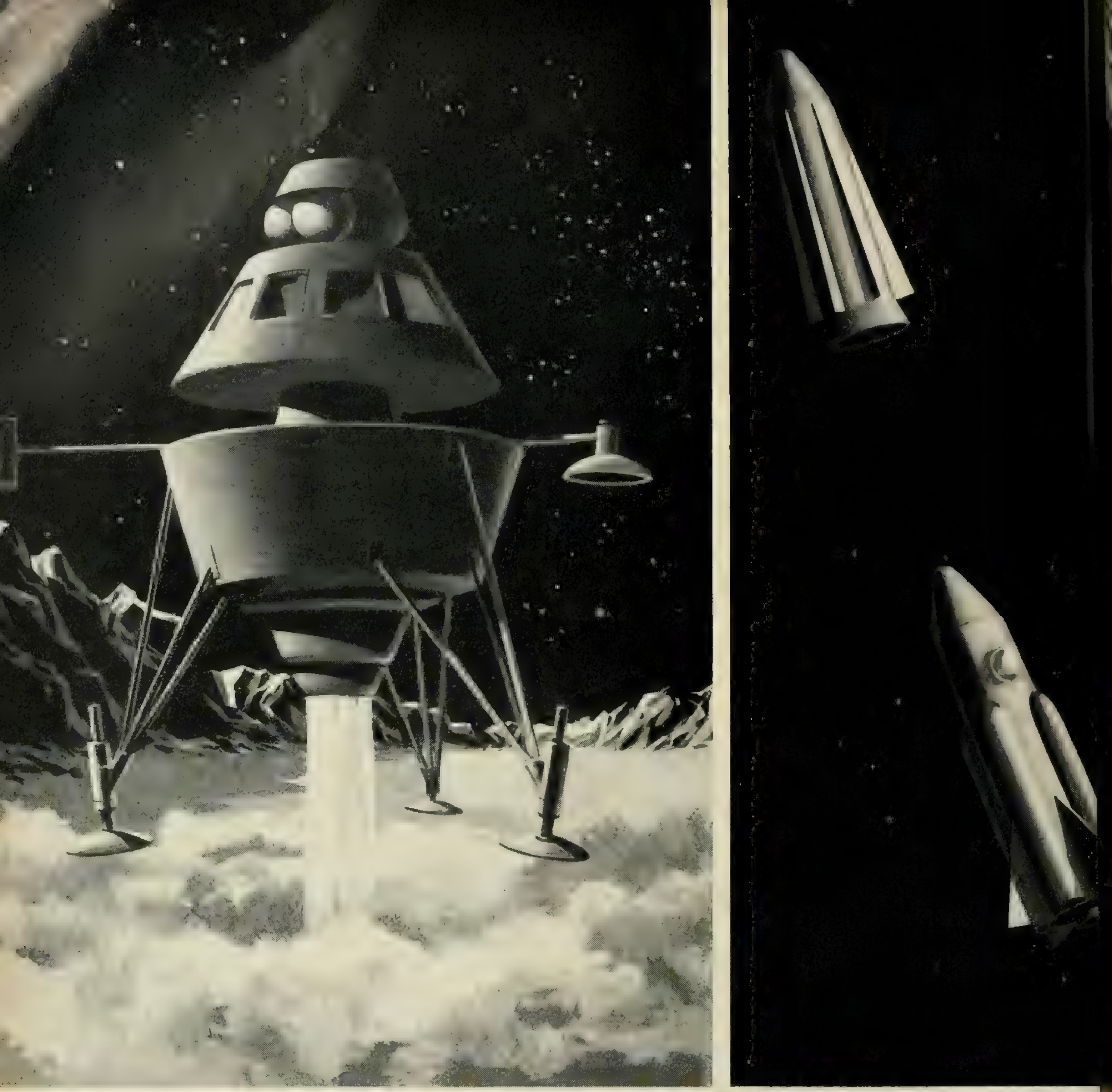
REMARKS: First five flights were unsuccessful; first two Rangers failed to launch from orbit; Ranger III launched Jan. 26, 1962, failed to impact on the Moon, went into solar orbit; Ranger IV impacted on the back side of the Moon April 26, 1962, but transmitted no data; Ranger V missed Moon and is now in solar orbit; next launch, third quarter 1963; program now includes 14 spacecraft, but eight more are planned

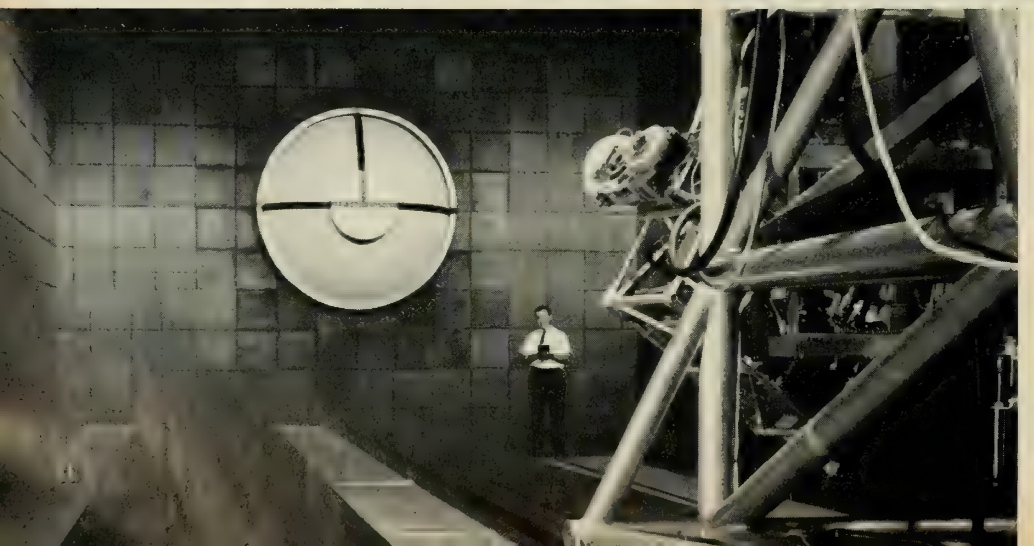
RANGER IV



PIONEER

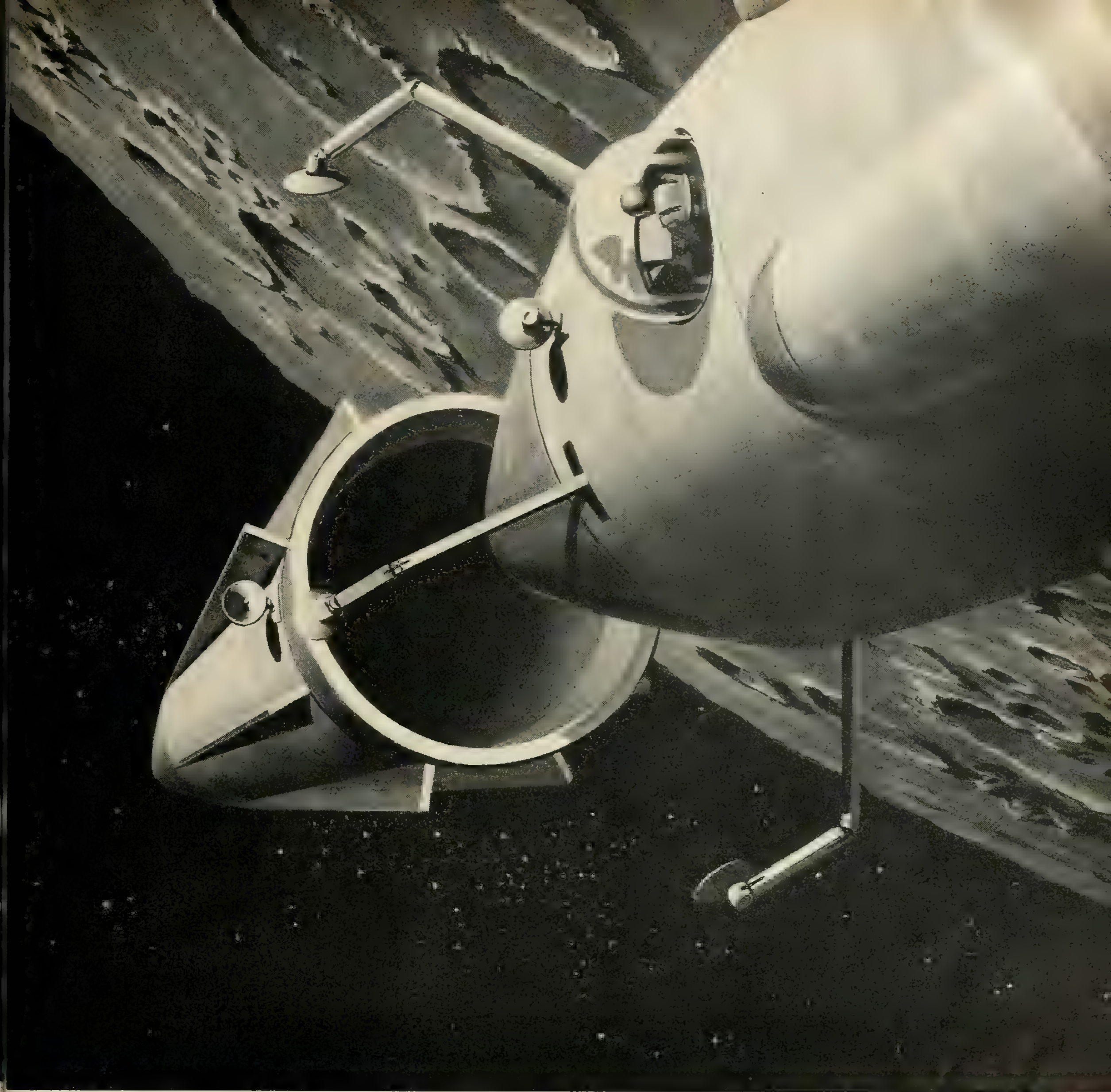






Top illustrations (l to right): Landi Rendezvous, Dockin

Left: Raytheon's P totype Rendezvo Radar installed the Martin Marie Company's Clos Test and Traini Facility.



RAYTHEON . . . a leader in radar for space vehicles

aytheon — leading designer and manufacturer for ound-based, aircraft, and missile systems — has eveloped and is testing prototype space radars for ENDEZVOUS . . . DOCKING . . . LANDING.

urrently being explored under Raytheon's in-house ace radar program are several interesting configu- tions. One of these, the Raytheon Rendezvous Radar, s been installed in the Martin Marietta Company's losure Test and Training Facility at Denver, Colorado. is applicable to such systems as Apollo, Lunar Logistics System, Mars Excursion or Command Module, Satellite Inspectors, and Manned Space Stations. Variations of the system are now being tested for particular missions.

For additional information — or a discussion of how the same Raytheon integrated system capability can be applied to your requirements — contact Neil A. Montone, Director, Marketing, *Space and Information Systems Division, Raytheon Company, Bedford, Massachusetts.*

RAYTHEON

Surveyor (NASA)

TYPE: Lunar soft-landing spacecraft

MISSION: soft-land 750-lb. spacecraft on the Moon

STATUS: R&D

PRIME CONTRACTOR: Hughes

INSTRUMENTATION: 115 lbs. of scientific instruments including stereo panoramic TV, X-ray diffractometer, surface sampler, touchdown dynamics, micrometeorite experiment

BOOSTER: Atlas-Centaur

REMARKS: First Moon flights scheduled late 1964; Seven soft landers planned

Voyager (NASA)

TYPE: Unmanned interplanetary spacecraft

MISSION: 6,000 lbs. (approx.); unmanned Mariner follow-on to orbit Mars & Venus and to inject a capsule to the surface

STATUS: Study

PRIME CONTRACTOR: JPL; study contracts with Avco & GE

INSTRUMENTATION: Not determined

BOOSTER: Saturn IB with third stage or equivalent

REMARKS: Study to aid in decision late this year; first flight possible in late 1960's

X-15 (NASA, Air Force)

TYPE: Manned rocket plane

MISSION: Provide data on hypersonic flight and serve as research craft for experiments related to space and aeronautical sciences

STATUS: R&D flight-testing

PRIME CONTRACTOR: North American Aviation

PERFORMANCE: Speed 4,105 mph; altitude 59 miles

FRAME: System contractor—North American; length, 50 ft.; launch weight, 33,000 lbs.; landing weight, 14,700 lbs.; wingspan 22.6 ft.

GUIDANCE: Inertial flight data system—Sperry Gyroscope; adaptive flight control electronics—Minneapolis-Honeywell

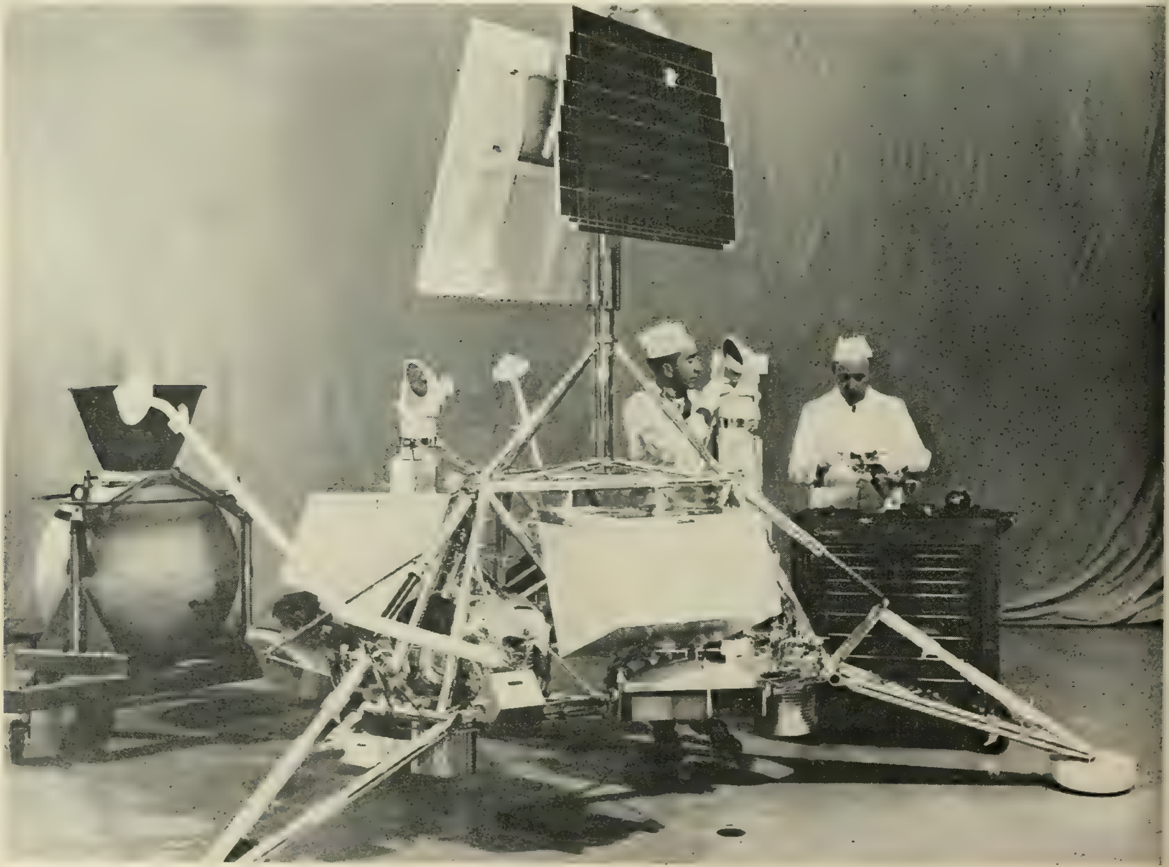
POWER UNITS: System contractor—General Electric

BOOSTER: System contractor—Thiokol; propellant—LOX and liquid ammonia

THRUST: 57,000 lbs. total from Thiokol Type XLR-99

REMARKS: Plane #3 set altitude record of 314,750 ft. July 17, 1962; plane #1 set new official speed record for manned power flight of 4,159 mph June 27, 1962; X-15 to be modified for one-year test program of air-breathing propulsion systems

SURVEYOR



X-20 Dyna-Soar (Air Force)

TYPE: Manned boost-glide spacecraft for research in controllable re-entry

STATUS: Under review

MANAGEMENT: Aeronautical Systems Division, AFSC, for initial phases; Space Systems Division, AFSC, for orbital phases

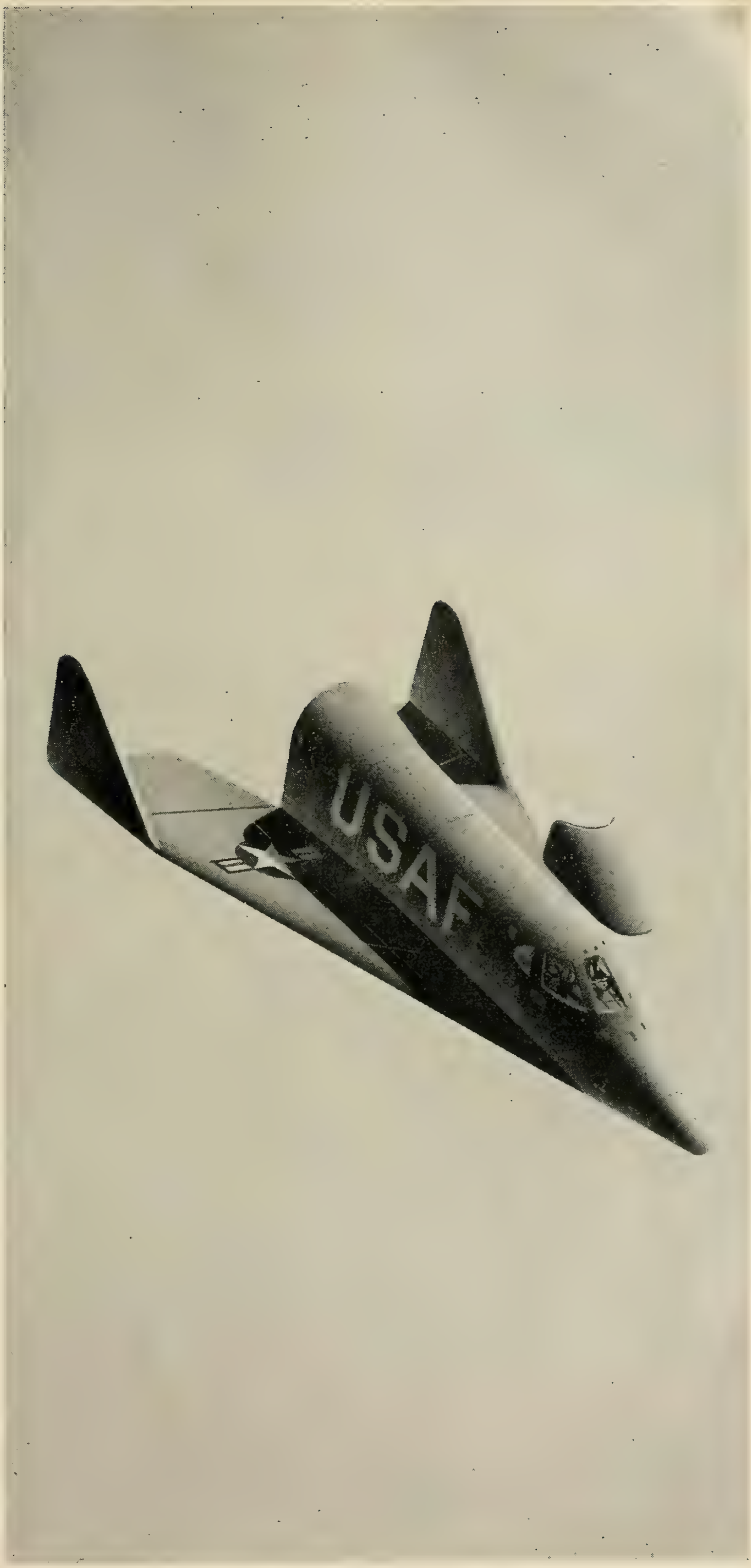
PRIME CONTRACTOR: Boeing

SUBCONTRACTORS: Martin, booster; Aerojet & Thiokol, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link; Sundstrand, auxiliary power; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system

CONFIGURATION: Delta-winged glider; one pilot; weight, 10,000 lbs.; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; major materials are refractory metals and ceramics; cooling during re-entry by radiation

BOOSTER: Titan III, using Aerojet-General liquid engines and United Technology Center solid engines

REMARKS: Considered most reviewed and re-oriented project in AF history; designation changed from Dyna-Soar, a bomber concept, to X-20 in order to stress research aspects of vehicle rather than weapon aspects; air-drop flights from B-52 expected later next year, followed by suborbital rocket launches, then orbital launches "possible" if mission is justifiable



X-20 (DYNA-SOAR)

Satellites

ANNA (NASA)

TYPE: Geodetic satellite

MISSION: Provide a triangulation point in space for determining distances and positions on Earth; continue geodetic measurements of Earth

BOOSTER: Thor-Able Star

PRIME CONTRACTOR: Bureau of Naval Weapons/Applied Physics Lab

FRAME: Shape—36-in. aluminum sphere (with solar cell belt, 48 in.); weight—355 lbs.

INSTRUMENTATION: Flash tube experiment—USAF Electronics Systems Div./Edgerton Germeshausen & Grier, Inc.; type—two sets of xenon flash tubes; function—produces a series of five light flashes about 20 times a day to provide triangulation point; secor experiment—USA Corps of Engineers/Cubic Corp.; type—CW transmitter (162-324 mc) for geodetic measurements and 54-216 mc for refraction studies; function—interrogated on six or seven passes each day for range determination based on Doppler shift observations

REMARKS: First ANNA launch May 10 failed when Able-Star failed to ignite; second launch successful Oct. 31, 1962; NASA to launch about one per year beginning in 1964

ARENTS (ARPA)

MISSION: Investigate space environment out to 22,000 mi. as part of Vela-Hotel program; subsidiary mission to test long-term behavior of components in that environment; involves system of three satellites

PRIME CONTRACTOR: General Dynamics/Astronautics

BOOSTER: Atlas-Centaur

REMARKS: Under review due to Centaur delay; another booster may be chosen; will be launched as piggyback payload aboard larger payload; name an acronym for Advanced Research Environmental Test Satellite

BIOS (NASA)

TYPE: Small unmanned satellite

MISSION: Test effects of spaceflight on various life forms including primates for periods of up to two weeks

STATUS: Study

PRIME CONTRACTOR: None; study contracts by GE, Lockheed and Northrop

BOOSTER: Not determined

REMARKS: Program decision expected in Fiscal '64; flights to begin in calendar year 1964

ECHO II

Discoverer (Air Force)

DESIGNATION: Part of WS-117L, now re-designated Program 622A

MISSION: Military satellite test-bed

STATUS: Operational

PRIME CONTRACTOR: Lockheed, overall; GE, re-entry vehicle; Bell Aerospace, propulsion

PERFORMANCE: Variable orbits, depending on mission; multi-restart engine gives considerable latitude

CONFIGURATION: Uses Agena-series satellites; initial configuration—length, 19.2 ft.; diameter, 5 ft.; weight, about 1,700 lbs.; all dimensions except diameter increase 1/3 to 1/2 depending on payload

BOOSTER: Thor or Atlas with Agena upper stage

RE-ENTRY VEHICLE: GE-designed, capsule type, 27-in. length, 33-in. diameter, weight about 300 lbs.

REMARKS: Program life extended due to considerable success; data on program now classified; used for testing space effects on bioastronautic specimens, materials and equipment; was forerunner and test-bed for MIDAS and SAMOS programs

Echo (NASA)

TYPE: Inflated balloon passive communications satellite

MISSION: Reflect radio signals off 135-ft. inflatable sphere in a 700-to-805-statute-mile orbit

STATUS: R&D

PRIME CONTRACTOR: NASA

FRAME: Mylar plastic and aluminum foil laminate

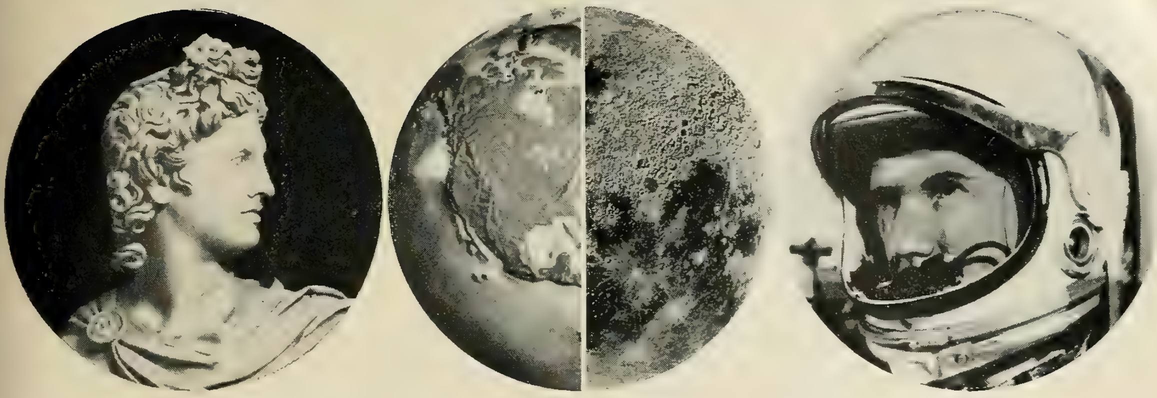
INSTRUMENTATION: Tracking beacons on sphere

POWER UNITS: Batteries and solar cells

BOOSTER: Thor for ballistic tests; Thor-Agena for orbital flights

REMARKS: Echo I in orbit since Aug. 12, 1960; two ballistic shots were conducted from AMR—first Jan. 15, 1962 (sphere ruptured), second July 18, 1962 (sphere inflated safely but was underpressured); orbital launch from PMR planned late this year; functioning of sphere will be tested

GENERAL ELECTRIC ENGINEERING OPPORTUNITIES



ACT NOW FOR ASSIGNMENTS ON PROJECT APOLLO

> *"The requirement for the Integration and Checkout program arises from the unique characteristics . . . of Apollo . . . which distinguishes it from other projects. These include (1) the serious consequences of failure as measured in terms of national prestige, human life and cost; (2) the complexity . . . in terms of the technology required and the numbers and types of industrial contractors involved; and (3) the long period of operations in the space environment with no significant maintenance or repair possible."*
>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

General Electric's Apollo Support Department has been selected to assist NASA in the integration support, checkout and reliability assessment of the Apollo system. Without doubt, it takes an unusually mature and competent man to perform under the realization that his individual work can be of significant importance to such a program.

If you are the kind of person who thrives on such responsible work, there's a place for you with General Electric. We've already put together the most impressive team ever assembled in the General Electric Company for this program . . . however, there are *many* opportunities still available to the *right* men. From the listings below you can determine your own opportunities. **Contract Programs:**

CHECKOUT . . . work consists of two distinct parts. First, a continuation of current engineering study efforts to provide NASA with checkout systems analysis, standardization studies, an integrated space vehicle checkout system specification, studies of test procedures, the application of advanced checkout techniques to Apollo, and system checkout engineering support at NASA field centers. Second, provision of checkout equipment to be included within the integrated launch control and checkout system.

RELIABILITY ASSESSMENT . . . effort includes assisting NASA in assessing overall mission reliability and safety levels, implementing a reliability and failure data system, and reviewing reliability and quality procedures and controls.

INTEGRATION SUPPORT . . . assist in identification and documentation of equipment and procedure interfaces within the Apollo project. Studies of integration methods and their application to Apollo including configuration control, and data handling.

Engineering experience required in: SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

- ☐ **Complex Systems Design**
- ☐ **Guidance Control Systems**
- ☐ **Telemetry Systems**
- ☐ **Electronics Packaging Design**
- ☐ **Logic Design**
- ☐ **Human Factors**
- ☐ **Systems Engineering**
- ☐ **Cryogenics**
- ☐ **Engineering Writers**
- ☐ **Computer Engineering**
- ☐ **Computer Programming**
- ☐ **Data Processing Display**
- ☐ **Circuitry & Circuit Design**
- ☐ **Data Analysis**
- ☐ **Launch Facilities Systems**
- ☐ **Instrumentation & Simulation Systems**

IF YOU ARE THE CALIBRE OF ENGINEER WHO CAN SHOULDER THE RESPONSIBILITIES THESE JOBS ENTAIL, WE HAVE IMMEDIATE OPENINGS IN HUNTSVILLE, ALABAMA; CAPE CANAVERAL, FLORIDA; DAYTONA BEACH, FLORIDA; AND HOUSTON, TEXAS.

Write today to: Mr. P. W. Christos, Apollo Support Department, General Electric Co., Support Building, Room 73-O P.O. Box 2500, Daytona Beach, Florida. (Your inquiry will be held in strict confidence. Please include your salary requirements.)

APOLLO SUPPORT DEPARTMENT
A Department of the Command Systems Division

GENERAL ELECTRIC

An Equal Opportunity Employer

Pick a star

Whatever star you choose—it can be as faint as 2.5 visual magnitude—Eclipse-Pioneer's star tracker subsystem will acquire and lock onto it, and provide displacement error signals for use by space vehicle attitude control and navigation systems.

Under development in cooperation with the NASA-Goddard Space Flight Center, the Star Tracker consists of a refractive type telescopic optical system, with integral electronics, supported by precision pitch and roll gimbals, each with ±60° authority. The telescope assumes a star intercept angle in response to an external command signal. When star presence is sensed, the system automatically switches to track mode and supplies the vehicle control system with error signals proportional to the difference between command signal and telescope position.

The system has a command positioning accuracy of

and lock onto it.

30 arc seconds and a self-tracking accuracy of 10 arc seconds. It is a passive thermal system designed to withstand the hard vacuum of space environment without the use of hermetic seals. The telescope uses a 7″ focal length objective lens with a 1.5″ clear aperture. The light sensitive element is protected from incident sunlight by an automatically operating reflective shutter.

Eclipse-Pioneer's Star Tracker subsystem is just one in a long list of guidance, stabilization and control systems designed for aerospace vehicle assignments. Others on the list include hot gas control systems, adaptive control systems, inertial guidance, advanced displays, reaction wheels and spheres, sun sensors, and letdown, approach and landing systems.

For more detailed information, write to us in Teterboro, New Jersey.

Eclipse-Pioneer Division

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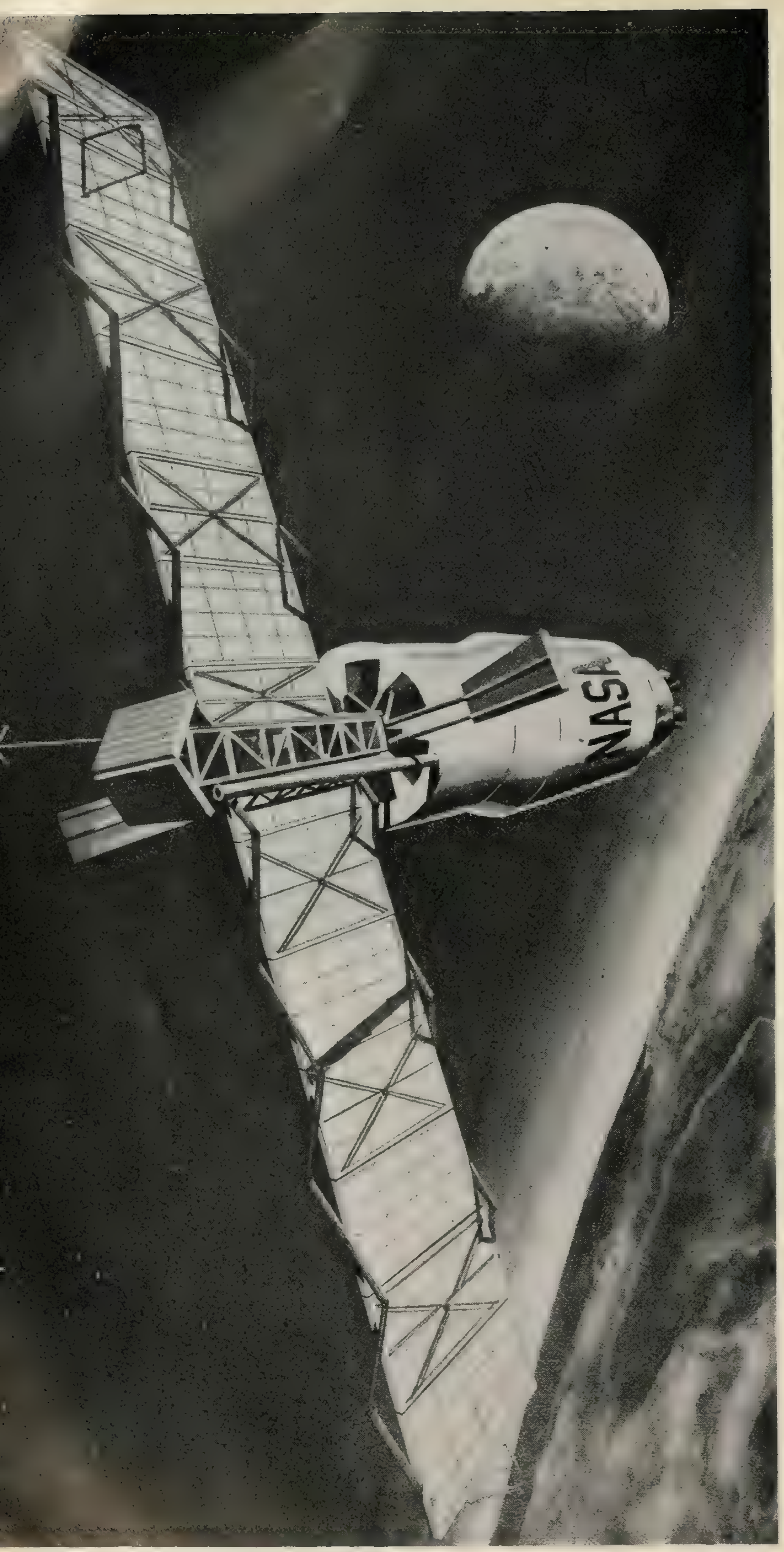
THE Bendix CORPORATION

WHERE IDEAS
UNLOCK
THE FUTURE



METEOROID DETECTION SATELLITE

High-Altitude Communications Satellite (Air Force)

TYPE: Communications satellite

STATUS: Early development

PRIME CONTRACTOR: ITT, systems engineering and technical direction

PERFORMANCE: Orbit about 22,000 n. mi.; station-keeping active repeater weighing under 500 lbs.; 3-10 simultaneous satellites comprise system; wide bandwidth

BOOSTER: Atlas-Agena D

PAYLOAD: Wide-bandwidth equipment with encryptographic and anti-jamming capabilities

SUPPORT EQUIPMENT: Advent ground stations in Fort Dix, N.J., and Camp Roberts, Calif.

REMARKS: One of two programs initiated by DOD after Advent cancellation in June, 1962; similar to NASA's Syncom; responsibilities identical to those of medium-altitude system; operational capability expected by 1966, following initial operational capability in 1964

Interplanetary Monitoring Probe (NASA)

TYPE: Unmanned satellite

MISSION: 125-lb. satellite designed to measure radiation and solar flares

STATUS: R&D

PRIME CONTRACTOR: Goddard Space Flight Center

POWER UNIT: Solar cells; Martin Co. also developing nuclear power unit for later use

BOOSTER: Delta

REMARKS: Eight satellites to be developed; first launch late this year

Medium-Altitude Communications Satellite (Air Force)

TYPE: Communications satellite

STATUS: Early development

PRIME CONTRACTOR: GE, Philco, STL—program definition studies

PERFORMANCE: Will orbit at 5,000-12,000 mi.; polar; multiple-launch active repeater; 24-36 satellites in orbit simultaneously; weight less than 150 lbs.

PAYLOAD: Narrow bandwidth, voice and teletype equipment

SUPPORT EQUIPMENT: Expected to use Advent stations at Fort Dix, N.J., and Camp Roberts, Calif.

REMARKS: One of two programs initiated after cancellation of Advent program in June, 1962. Management responsibilities: interface problems, Defense Communications Agency; satellite system, AF; ground installations, Army; may be fully operational by 1966, following hoped-for initial operational capability by 1964

Meteoroid Detection Satellite (NASA)

TYPE: Unmanned satellite for meteorid measurement

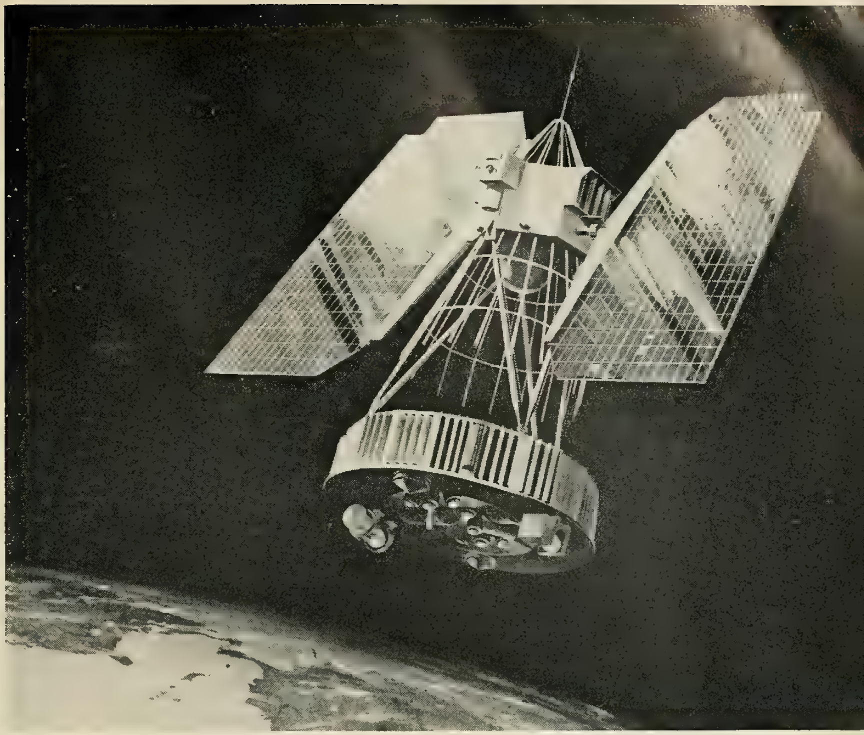
MISSION: Supply design information on micrometeoroid hazard and flight-test micrometeoroid sensor; 3,400 lb. satellite employs two 50 x 15-ft. extendable detector wings; Earth orbit 300 to 800 mi.

STATUS: R&D

PRIME CONTRACTOR: Fairchild Stratos

BOOSTER: Saturn I

REMARKS: First launch scheduled for mid-1964; two will be orbited



NIMBUS

MIDAS (Air Force)

MILITARY DESIGNATION: Part of WS-117L, redesignated Program 239A

TYPE: Early warning satellite

STATUS: Re-oriented back in development cycle due to sensor problems

PRIME CONTRACTOR: Lockheed

PERFORMANCE: Orbits at 300-3,000 mi.; polar; detects and warns of enemy ballistic missile launches; has had difficulty discriminating launches from other stimulation but problem is believed solved

CONFIGURATION: Length, 30 ft.; diameter, 5 ft.; weight, 3,500-5,000 lbs. including complete Agena stage; capsule payload classified; solar cell paddles for extended life

INSTRUMENTATION: Infrared radiation sensors by Aerojet-General; data-link telemetry and tape-fed programmer

BOOSTER: Atlas-Agena or Thrust-Augmented Thor

REMARKS: Was open program until secrecy order of March, 1961; orbital system changed from one of precise orbits to one of random orbits; plans now being implemented for integration of advanced payloads with new sensors; DOD's Harold Brown told Congress half of the $450 million spent on MIDAS was wasted

Nimbus (NASA)

TYPE: Second-generation weather satellite

MISSION: 750-lb. satellite in 500-mi. near-polar Earth orbit

STATUS: R&D

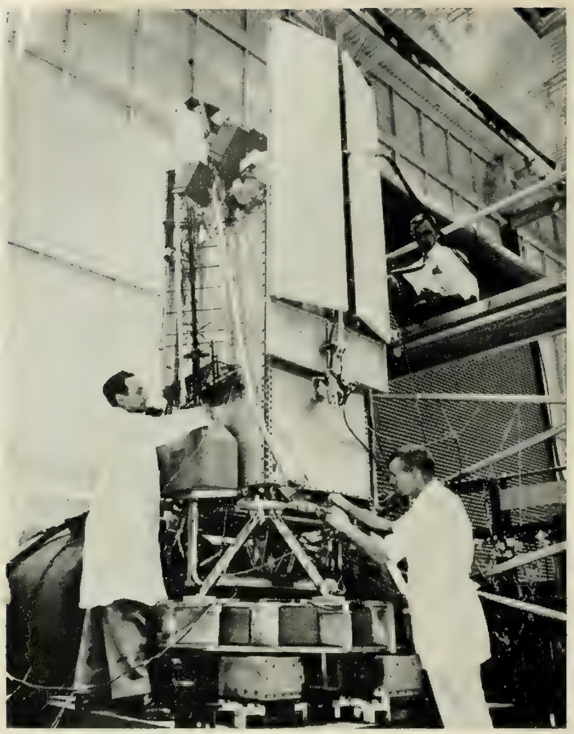
PRIME CONTRACTOR: Goddard Space Flight Center; integration and testing, General Electric

INSTRUMENTATION: RCA vidicon cameras for cloud data; radiation sensors at various resolutions and spectral ranges for heat balance, temperature and cloud cover

POWER UNITS: Solar cells and batteries

BOOSTER: Thor-Agena

REMARKS: Four R&D flights 1963-1966; five operational satellites planned 1964-1966; more expected



OGO

Orbiting Astronomical Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 3,500-lb. orbiting satellite to study astronomical phenomena

STATUS: R&D

PRIME CONTRACTOR: Grumman

GUIDANCE: GE, stabilization and control; IBM—computer; Kollsman —star trackers

INSTRUMENTATION: Telescope with 36-in. primary mirror, spectrometer

BOOSTER: Atlas-Agena

REMARKS: Three flights scheduled beginning in 1965; first flight will attempt a detailed map of the sky in ultraviolet light; OAO will be used to develop a standard space observatory

Orbiting Geophysical Observatory (NASA)

TYPE: Large unmanned scientific satellite

MISSION: 1,000-lb. satellite with instruments for geophysical measurements, polar and eccentric shots planned

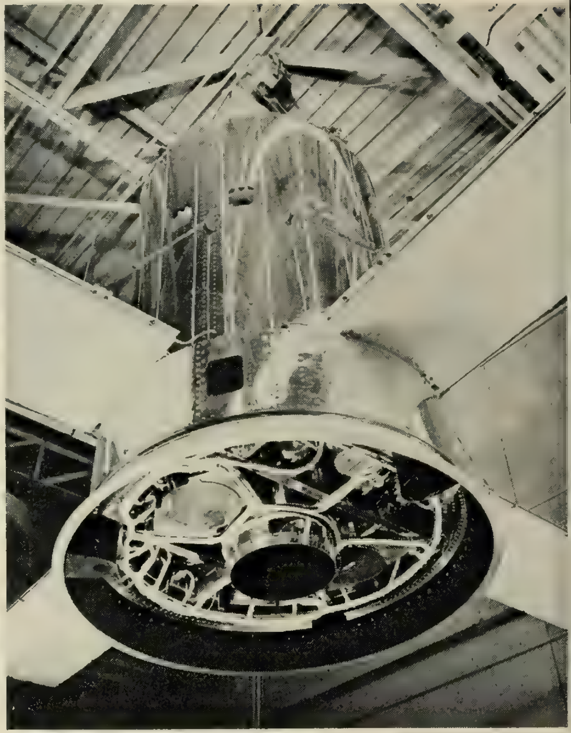
STATUS: R&D

PRIME CONTRACTOR: Space Technology Laboratories (STL)

PERFORMANCE: Capable of accommodating up to 50 experiments

BOOSTER: Atlas-Agena B and Thor-Agena D

REMARKS: Six launches scheduled beginning in 1964



OSO

Orbiting Solar Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 440-lb. orbiting satellite to study solar flare radiation from the Sun

STATUS: R&D

PRIME CONTRACTOR: Ball Brothers

BOOSTER: Thor-Delta

REMARKS: First flight March 7, 1962, successful; seven additional OSO B-H scheduled beginning later this year

Advanced Orbiting Solar Observatory (NASA)

TYPE: Unmanned satellite

MISSION: 1,000-lb. satellite will be launched into polar orbit and be able to point all experiments at Sun with accuracy of 5 sec. of arc or 1/360th of Sun's diameter

PRIME CONTRACTOR: Republic

BOOSTER: Atlas-Agena

REMARKS: First launch scheduled for 1967

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$m_1 + t + m_2 (a\ c) = d_p$*

BETWEEN INFINITY AND EARTH, in the far reaches of space, accuracy and reliability in command and control is the key to success in missile, satellite and space vehicle missions.

DYNALECTRON has set a high level of performance in its broad missile range and space program responsibilities, most notably in the areas of telemetry, instrumentation, calibration, date acquisition, data reduction, and research and development for missile range and space vehicle systems and equipment. Its operational sites include White Sands Missile Range, Holloman AFB Aeromedical Research Laboratory, Pacific Missile Range at Point Mugu, NASA's Goddard Space Flight Center, and Project Mercury Tracking Station at Corpus Christi. Everywhere, **DYNALECTRON's** performance is measured thus:

The best of men and management (m_1), plus tools (t), along with materials (M_2), multiplied by ready availability (a) and proven capability (c) of the men who use them, equal performance (p) in the dependable* **DYNALECTRON *manner.*

A diversified international organization, **DYNALECTRON** is also engaged in the maintenance, modernization, retrofit and overhaul of aircraft and missiles—on site or at its own facilities—the production of electronic components and systems, the manufacture of medical x-ray and transformer equipment, and in the sale of aircraft and associated aviation products.

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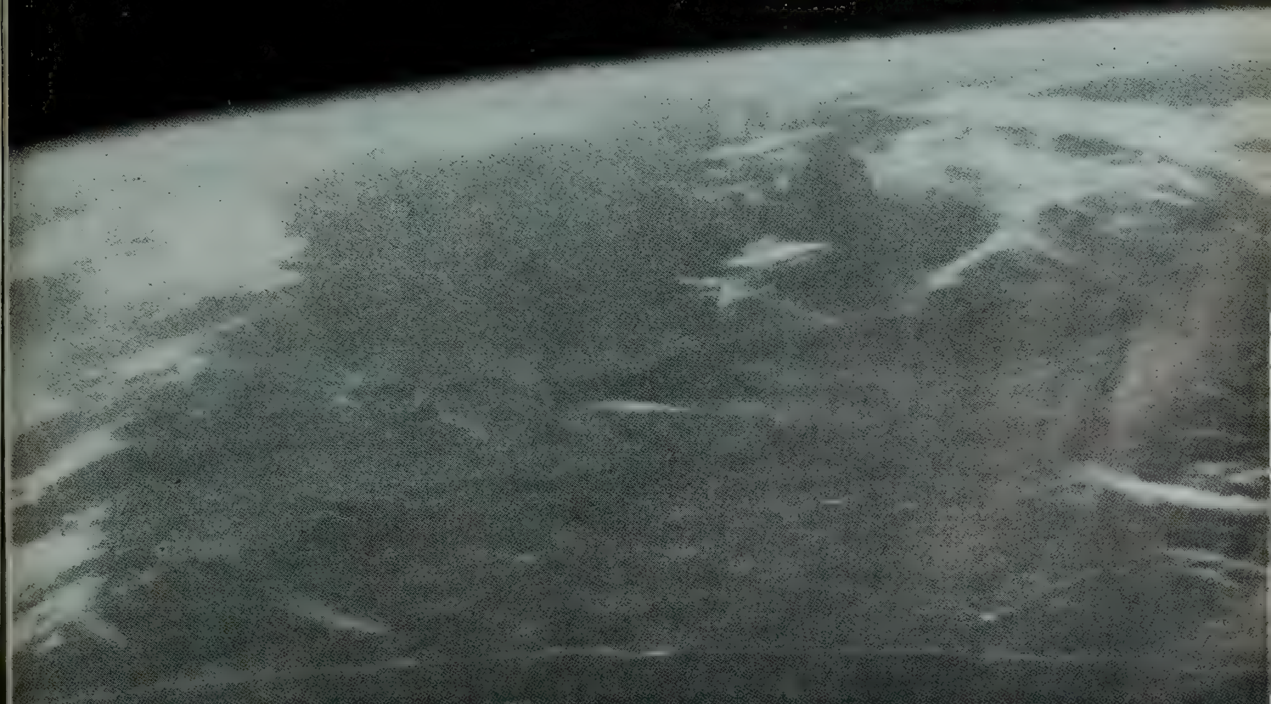

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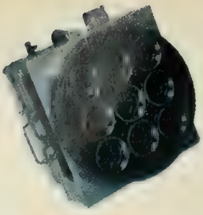


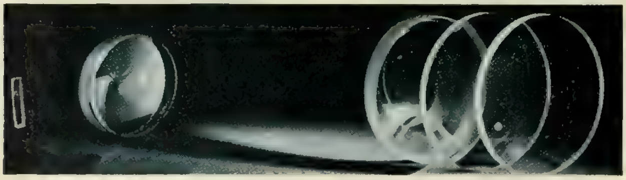
Itek Trends/Optics

COMMUNICATING THE EARTH'S "PULSE"

Each year, 125 seismic stations around the world record some 300,000 seismograms. These records are made by a galvanometer-mirror light-beam, in response to movements within the earth. The resulting seismogram is a 1 x 3 foot recording of fine-line tracings on photographic paper having varying density and an average contrast level of 2:1. The unusual size and contrast of these records made reproduction impractical and seismologists were forced to work exclusively with original records. Because this method was so inefficient, the U.S. Coast and Geodetic Survey gave Itek Corporation the job of developing a solution.

An Itek information system is now the heart of a new Seismology Data Analysis Center operated by the Survey in Washington, D. C. The center of this system is a copy camera using a finite conjugate panoramic lens with a resolution of approximately 400 l/mm. It makes a 70mm microfilm recording of each seismogram in less than thirty seconds and simultaneously records an identification record in both human-readable, alpha-numeric code and machine-readable, binary code.

This camera is but one item in the information handling system, a complete description of which is available on request. We think it is interesting for two reasons. First, it decribes Itek's capability to solve unusual problems in information technology through an interdisciplinary approach (optics and information sciences), and secondly, it shows an extension of an optical technique which, in recent years, has found its major use in aerial reconnaissance.



LENSES

This photograph shows the six elements in one of our recent lens designs. Weighing under 20 pounds, it is a 24-inch, f/3.5 system which has consistently produced a resolution of 160 l/mm on SO132 film at a 2:1 contrast ratio. A similar design has most recently been used on a 66-inch f/4 system producing 140 l/mm at a 2:1 object contrast and we are in the process of testing a 40-inch system of the same design.

We have available a collection of data sheets on our most popular lenses — including the 240-inch, f/16 all-metal Cassegrainian Telescope. The data sheets are yours for the asking.

SPECTRAL SIGNATURE

Based on the concept that all earth objects or conditions have a distinctive electromagnetic signature, a nine-lens camera system was designed as an aerial inspection instrument. The camera (top of page) is capable of photographing from 0.4 to 0.9 microns and with spectrometers, the system provides a coverage of spectral signatures from 0.4 to 5.0 microns. For information about the nine-lens camera or Itek's aerial photographic analysis center, contact West Coast Operations, 1450 Page Mill Road, Palo Alto, California. You may also be interested in the spectral sensitometer which Itek has developed and which is being offered for sale at $18,500.

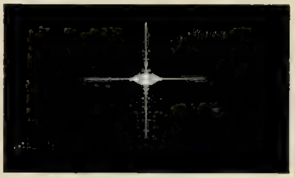
FLYING-SPOT SCANNERS

The scientists in our electro-optical research group are conducting studies to determine methods of counting human nerve cells electronically. Using Itek built UHR-CRT's and a microscope objective, they have devised a technique which uses 2000 scan lines with a frame presentation of 7 per second. Resolutions of 800 l/mm were obtained on the slide and magnifications of 400 diameters on the display.

The above photograph was made from a display showing a single cell micro-organism in a local untreated water supply. Other less unusual applications have included graphic readouts, spatial frequency analyzers, computer output and input, panoramic stereo rectification, spark and cloud chamber photo analysis, and map reproduction and transmission systems.

OPTICAL DESIGNS

This spot diagram of a triplet lens was generated in less than 10 seconds on the display console of a highspeed computer which is used in optical design work. In the previous 30 seconds, the computer generated and displayed the lens diagram showing pupil and image planes, meridional and sagittal ray traces and the modulation transfer function over a wavelength interval. This type of optical design programming allows the Itek lens designer to evaluate many alternate optical systems for optimum performance at minimum cost.



Itek

For complete information about Itek Trends/Optics, Contact Department MR-120

Itek Corporation

10 MAGUIRE ROAD, LEXINGTON 73, MASSACHUSETTS

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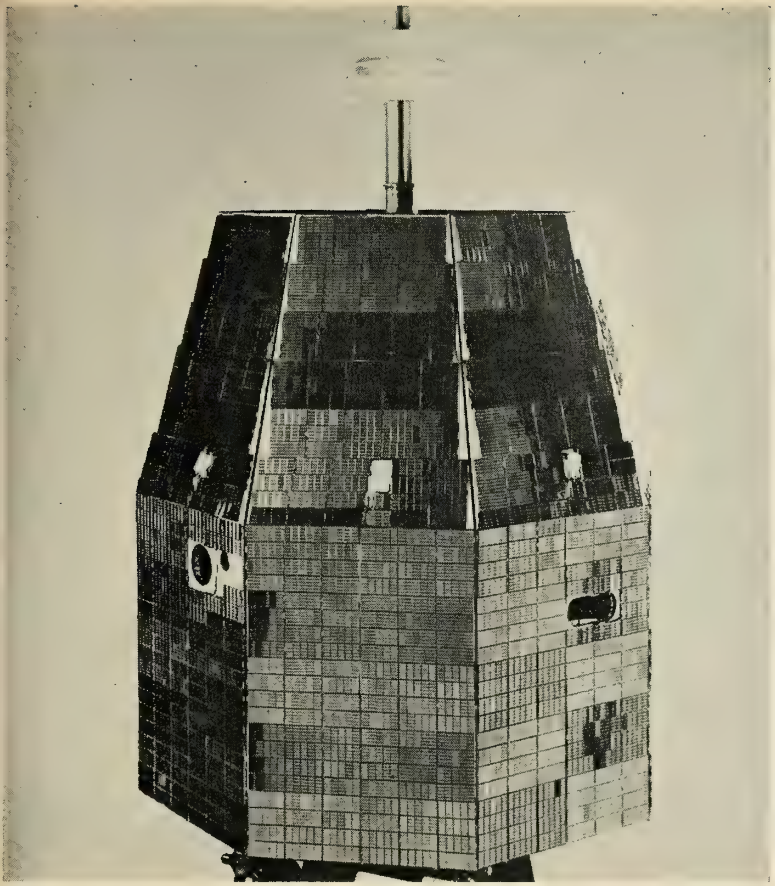


RELAY

Relay (NASA)

TYPE: Low-altitude active communication satellite

MISSION: Receive and transmit radio and TV signals via the 172-lb. active repeating satellite in a 700 to 40,000 n. mi. orbit

STATUS: R&D

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Duplicate systems for receiving and re-transmitting wideband TV, telephone and data signals; can handle a television transmission or 12 two-way voice channels; radiation monitoring and radiation damage detectors

POWER UNITS: Solar cells and batteries

REMARKS: Britain, France, Brazil and Germany building ground stations; Relay I in orbit Dec. 13, 1962; initial malfunction first apparent on fourth orbit corrected during December; successful use of satellite for experiments and demonstrations from Jan. 5, 1963, to present involving stations in U.S., Britain, France, Brazil and Italy, Germany and Japan constructing stations to participate in later launches; one additional launch planned for late 1963 with backup scheduled for 1964

Satellite Inspector (SAINT) (Air Force)

TYPE: Satellite inspection system, Program 706

STATUS: Early development

PRIME CONTRACTOR: RCA; Hughes, detection equipment

PERFORMANCE: Must be able to detect and rendezvous to within 50 ft. of another spacecraft or satellite, changing altitude and orbital plane accordingly; will be equipped with kill mechanism to neutralize proven hostile vehicles

PAYLOAD: Expected to incorporate TV, optical, infrared radar and radiation sensors

REMARKS: Progress not clear; feasibility demonstration originally slated for 1962, program now reoriented; study contracts may be let for further refinement of system, possibly based on Gemini

SAMOS (Air Force)

MILITARY DESIGNATION: Part of WS 117L, re-designated to unknown program number

TYPE: Reconnaissance satellite

STATUS: Operational

PRIME CONTRACTOR: Lockheed; sensors, Eastman Kodak; re-entry capsules, GE; recovery system, Avco & Northrop

CONFIGURATION: Length, 22 ft.; diameter, 5 ft.; weight, 4,100 lbs. with E-5 capsule, 3,000 lbs. with E-6 capsule; weights include entire Agena stage

PERFORMANCE: Polar orbit of 100-300 n. mi.; solar cell paddles extend operating time

INSTRUMENTATION: Photo intelligence equipment by Eastman Kodak

BOOSTER: Atlas-Agena or Thrust-Augmented Thor

REMARKS: System has highest national priority for recon efforts; consists of 6-9 satellites; 20-day life for photo equipment aboard; processed film scanned by TV for immediately useful data, then recovered from orbit for detailed analysis after useful life ends; electronic-eavesdropping version known as Ferret picks up communications and carries out electronic intelligence; advanced version under development; originally known as Sentry; even present name is classified; photos reported to be of same quality as high-altitude aircraft capability

SERT (NASA)

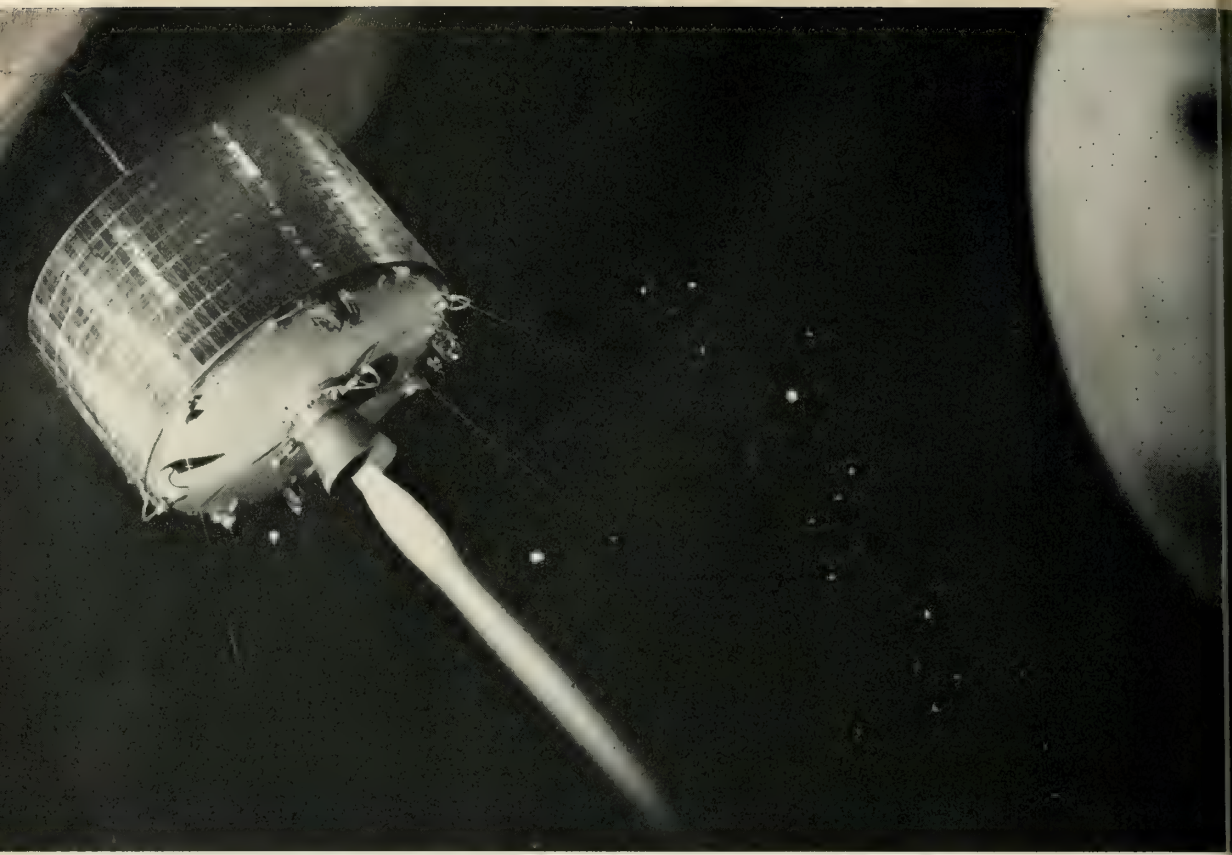
TYPE: Ballistic trajectory test vehicle

MISSION: To test electrical engine parameters

STATUS: R&D

PRIME CONTRACTOR: RCA

REMARKS: First flight expected late 1963 or early 1964



SYNCOM

Syncom (NASA)

TYPE: High-altitude active communications satellite

MISSION: Receive and transmit signals by way of 63-lb. satellite in a 22,300-mi. orbit

STATUS: R&D

PRIME CONTRACTOR: Hughes

INSTRUMENTATION: Communications, antenna, solar sensor, traveling wave tube, nickel cadmium batteries

POWER UNITS: Solar cells

BOOSTER: Delta

REMARKS: Launched successfully into synchronous orbit on Feb. 14, 1963, but electrical failure on day of launch kept satellite from operating; second launch scheduled July 1963; seven satellites will be built with a total of three flights planned

Advanced Synchronous Satellite (NASA)

TYPE: Advanced high-altitude active communications satellite

MISSION: Receive and transmit signals by way of 500-lb. satellite in a 22,300-mile-high orbit

STATUS: Study

PRIME CONTRACTOR: Hughes

INSTRUMENTATION: Not determined

POWER UNITS: Solar cells & batteries

BOOSTER: Atlas-Agena

REMARKS: No production or launching of satellites has been approved; it is dependent upon a successful launching of a Syncom satellite

Synchronous Meteorological Satellite (NASA)

TYPE: Meterological satellite

MISSION: To provide continuous monitoring of short-lived storms and cloud cover, and of the whole disc of the Earth

STATUS: Study

PRIME CONTRACTOR: None; study contract, Republic

PERFORMANCE: 22,300-mi. orbit permits remaining over one point on Earth's surface

INSTRUMENTATION: TV cameras that view the entire Earth and/or selected areas will be used along with suitable radiometers

POWER UNITS: Undetermined

REMARKS: First flights will occur no sooner than 1966

When the ultrasonic F 104 G Starfighter takes off on a mission, it relies on EEMCO actuators for maneuverability as well as the job of opening and closing the camera system door. In any situation, under any stress, this electromechanical rotary actuator allows the Starfighter to make the necessary mission pictures —bombing, target practice, or reconnaissance. Starfighters are also equipped with EEMCO actuators for the leading edge slat and the trailing edge flap. For further information on EEMCO-developed state-of-the-art actuators, motors, and starter-generators for aerospace and industrial applications, write or call the EEMCO Division of Electronic Specialty Co. at the address shown below.

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GENERAL DESCRIPTION, ACTUATOR D 1450

Actuator (Camera Door), Electro-Mechanical, Rotary Type D 1450 Degrees of rotation — 245 ±1 degree, Reversible, with brake and clutch, built in limit switches, R. N. filter ■ Mechanical end stops to limit maximum travel ■ Totally enclosed, explosion proof design ■ Normal operating load — 500 inch pounds ■ Current at 28 volts, dc — 3.9 amperes ■ Time — 5.0 seconds ■ Duty Cycle three complete cycles within one minute — off four minutes. Maximum operating load — 4,000 inch pounds (ice breaking load). Stall torque 5,100 inch pounds. Ultimate Static Load — 7,600 inch pounds. Qualified to Military Specifications MIL-A-8064A (USAF) and MIL-E-5272C (ASG). Weight 7.5 pounds.

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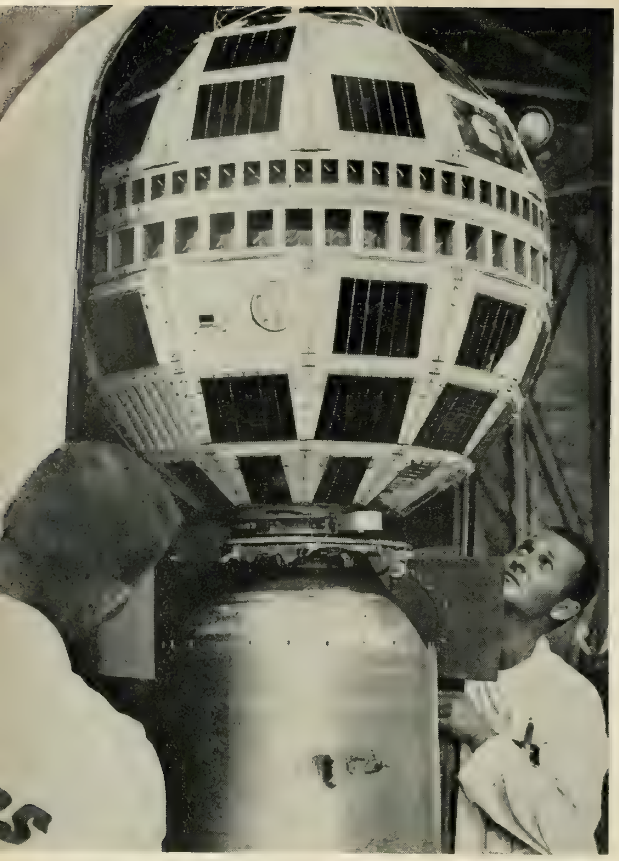
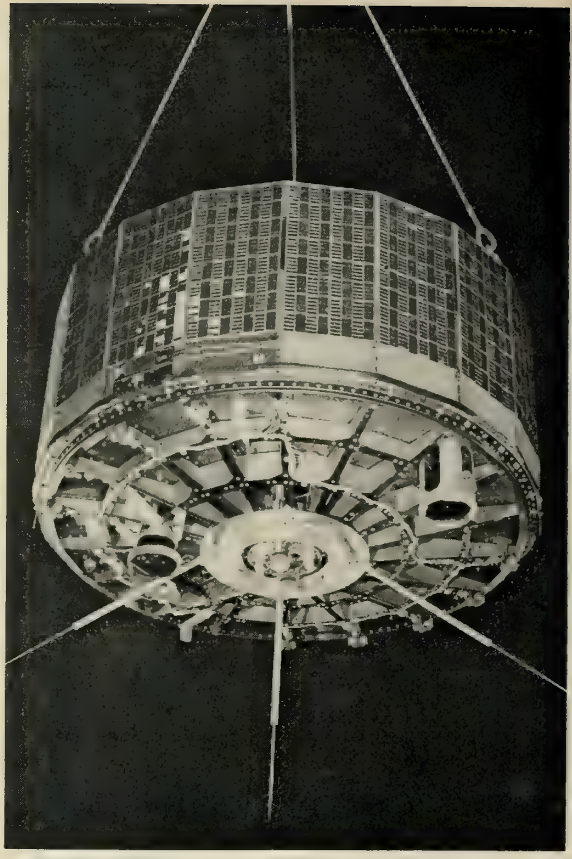


TELSTAR II



TIROS

Telstar (AT&T)

TYPE: Low-altitude active communications satellite

MISSION: Test broadband microwave communications in space; study radiation and micrometeoroid effects; test satellite tracking techniques

STATUS: R&D

PRIME CONTRACTOR: AT&T, launched by NASA on reimbursable basis

ORBIT: First flight elliptical inclined 45° to equator; 3,500 mi. apogee, 600 mi. perigee; second flight 6,500 mi. apogee, 500 mi. perigee

CONFIGURATION: Diameter, 34½ in.; weight, 170 lbs.

GUIDANCE: Command guidance system—Bell Telephone Laboratories

INSTRUMENTATION: Beacons, command receivers, narrow-band PCM-FM-AM telemetry; broadband communications

FRAME: Magnesium; framework shell, aluminum-coated with aluminum oxide

POWER UNITS: Nickel-cadmium batteries and solar cells

BOOSTER: Delta

REMARKS: First launch, July 10, 1962, successful; world's first active communications satellite; successfully received and transmitted TV pictures between America and Europe; second launch successful May 7, 1963

Tiros (NASA)

TYPE: Meteorological satellite

MISSION: 285-300-lb. meteorological satellite, TV pictures of cloud cover; transmits on ground command

STATUS: R&D

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Scanning and non-scanning radiation sensors; narrow, medium, and wide-angle cameras

POWER UNITS: Solar cells and nickel-cadmium storage batteries

BOOSTER: Delta

REMARKS: First launch April 1960; second, Nov. 23, 1960; third, July 12, 1961; fourth, Feb. 8, 1962; fifth, June 19, 1962; sixth, Sept. 18, 1962; seventh, June 19, 1963; all successful; six more launches planned through 1965

Transit (Navy)

TYPE: Navigation satellite

MISSION: Provide highly accurate position data to ships and aircraft on all-weather basis

STATUS: Nearly operational

DEPLOYMENT: Four satellites in random, near-circular orbits at 600-n. mi. altitude

PRIME CONTRACTOR: Applied Physics Lab for Bureau of Naval Weapons

BOOSTER: Scout

FRAME: Flat-topped drum shape 43 in. diameter, 31 in. high, weighing 250 lbs. for R & D model, and 50-100 lbs. in final model

INSTRUMENTATION: Electronic clock-memory system, magnetic stabilization system, four transmitters, solar cells and nickel-cadmium batteries

AUXILIARY POWER: Nuclear generator by Martin Co.

REMARKS: Expected to greatly reduce position errors for Polaris-firing submarines; was first satellite to use a nuclear power generator; NASA will use system to establish civilian navigation system

Vela-Hotel (ARPA)

TYPE: Detection-satellite system for nuclear explosions in space

STATUS: Development

PRIME CONTRACTOR: STL; sensors, Los Alamos Scientific Laboratory and Aerospace Corp.

PERFORMANCE: Three satellites in one orbital plane with three more in a plane 90° from the first; orbital altitude 60,000 n. mi.; can detect x-rays from a one-megaton nuclear explosion at a distance of 3 x 10^8 km; also has other detection equipment for gamma ray detection and complex memory logic

FRAME: 12-sided satellite for maximum coverage; weight, 300-400 lbs.; diameter, 40 in.

BOOSTER: Atlas-Agena B

REMARKS: Initial launch expected this year, after slipping from last year

TRANSPORTABLE SPACE COMMUNICATION TERMINAL

LUNAR SEISMOMETER FOR SURVEYOR

[illegible]

SPACE MISSIONS IMPLEMENTED FROM THE GROUND ON UP

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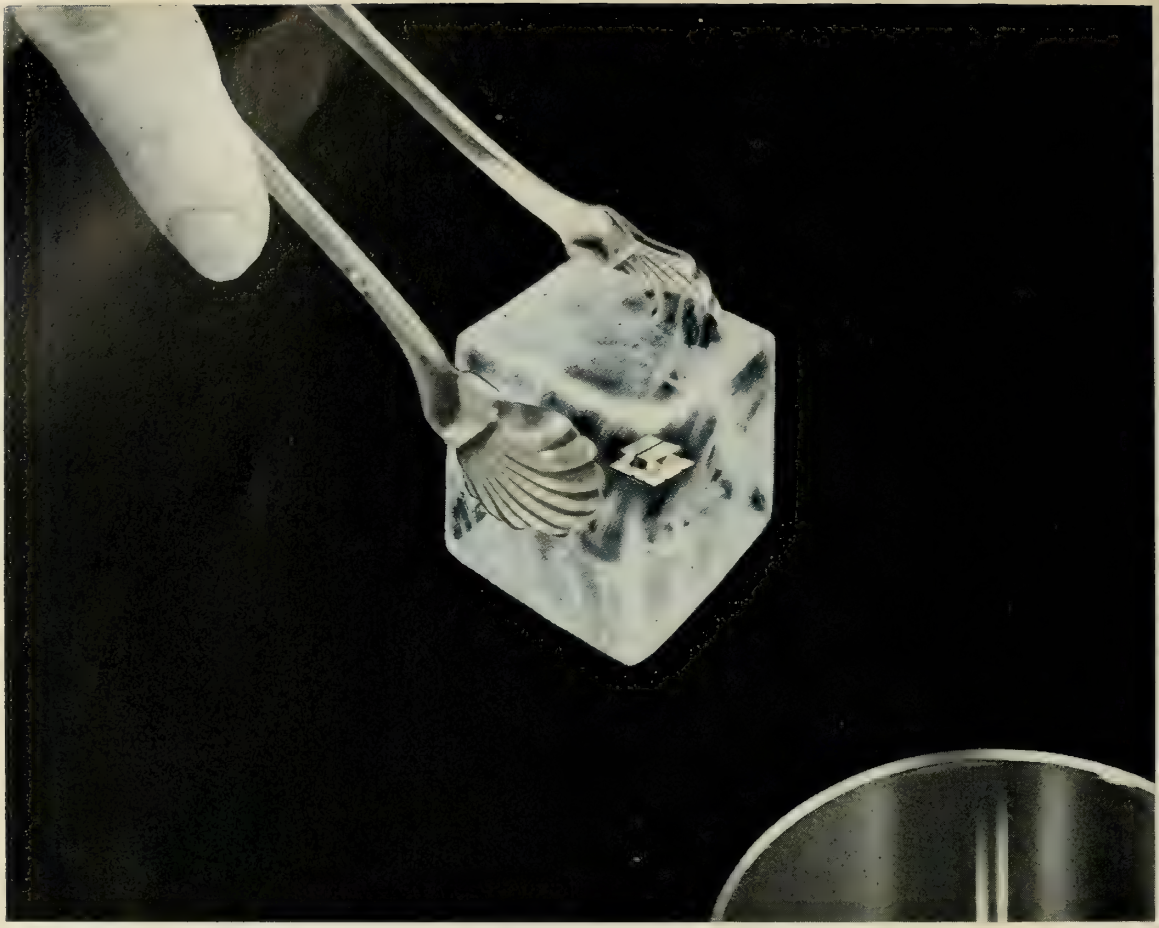

WHAT TEMPERATURE IS A BREAKTHROUGH?

This one is cold, and smaller than your thumbnail in size!

Melpar's spacecraft thermo-electric cooler emerged from a team effort which included solid state physicists, chemical physicists and electronics engineers working in a splendidly equipped laboratory and developmental shop. Research on this device was deepened by hot debate during in-house seminars . . . seminars designed to sharpen and extend new ideas.

The project was initiated under Company sponsorship, then quickly given an additional push by Government support. Breakthroughs come in many temperatures. They almost always have this kind of complex, cross-disciplinary history.

Throughout Melpar you find a "live" atmosphere, stimulated by research, matured by an experienced engineering and manufacturing team, created by fast-reacting, long-term-conscious management.

Our programs in aerospace sciences and systems, in the physical and life sciences, and in advanced electronics are growing. Expanding research groups now require additional staff members to work in the following areas:

■ **CHEMISTS AND PHYSICISTS**—flash photolysis, low temperature phenomena, high vacuum technology, ionic crystals, semi-conductor compounds, thermo-electric materials, refractory metal alloys, kinetics of gas solid reactions, gas phase kinetics, gas chromotography, thin film and monocrystalline microcircuits.

■ **MATHEMATICIANS**—the investigation of random function generators and the development of binary discreet and continuous random generators.

■ **ELECTRONICS ENGINEERS**—pattern recognition, signal signature analysis, data retrieval, speech processing and acoustic systems.

■ **BIOLOGISTS AND BIOCHEMISTS**—space biology and biological systems.

■ **OPERATIONS RESEARCH ANALYSTS**—model construction for special military operations and the quantitative analysis of detection, early warning and communications networks.

Write: Professional Employment Manager, 3800 Arlington Boulevard, Falls Church, Virginia.

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Vehicles

Agena B (Air Force)

TYPE: Upper stage

MISSION: Used as upper stage with Thor and Atlas boosters for many programs

STATUS: Operational

PRIME CONTRACTOR: Lockheed

CONFIGURATION: Length variable with payload requirements; 5-ft. diameter; basic weight of 1,700 lbs. variable with payload; sometimes equipped with solar cell paddles extending from base on scissors-arms; some models have afterskirt covered with solar cells; latter two configurations used on SAMOS and MIDAS

GUIDANCE: All-inertial by Minneapolis-Honeywell

PROPULSION SYSTEM: Liquid-propellant rocket originally developed by Bell Aerosystems for B-58 bomber pod; propellants, IRFNA/UDMH; thrust, 16,000 lbs.; restartable at least four times

PAYLOAD: Usable with a great variety of instrumentation and sensors

PERFORMANCE: Depends on booster—with Thor, 1,600 lbs. in 300-n. mi. orbit; with Thrust-Augmented Thor, about 4,000 lbs. in 300-n. mi. orbit; with Atlas D, over 5,000 lbs. in 300-n. mi. orbit; with Atlas D, 750 lbs. to escape velocity and 400 lbs. to Mars or Venus; use of Agena B with TAT has made use of Atlas unnecessary with MIDAS and SAMOS programs, and these have had cost reductions per launch

REMARKS: Used with SAMOS, MIDAS, Discoverer, Ranger, Mariner, OAO, OGO, Topside Sounder, Nimbus, Echo, Gemini, and other programs; an extremely versatile spacecraft, it is often used for piggyback launches (such as the ham radio satellite, Oscar, and the radiation-data satellite, TRS-1) and as a general workhorse; advanced version, Agena D, is being tested; Agena D will have greater length, thrust and propellant capacity; used by both AF and NASA

Atlas-Agena B (Air Force)

TYPE: Space booster

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Astronautics (Atlas); Lockheed (Agena)

PERFORMANCE: Payload—5,000 lbs. in 345-mi. orbit, 750 lbs. to escape, 400 lbs. for planetary missions

FRAME: Length—102 ft.; diameter (base)—10 ft.; launch weight—275,000 lbs.

GUIDANCE: System contractor—STL, Agena B; Minneapolis-Honeywell, inertial reference

PROPULSION SYSTEM: Booster—Rocketdyne (modified Atlas D); type—liquid; thrust—360,000 lbs.; Agena B—Bell Aerospace; type—liquid; thrust—15,000 lbs.; restart capability

PAYLOAD: Used in Ranger, Discoverer, MIDAS, SAMOS and other space programs

REMARKS: Improved, higher-thrust Agena D being developed for future space missions

Blue Scout (Air Force)

TYPE: Sounding probe and small-satellite launch vehicle

STATUS: Operational

PRIME CONTRACTOR: Aeronutronic; frame, Ling-Temco-Vought; guidance, Minneapolis-Honeywell; propulsion, Aerojet, Hercules Powder, Thiokol

PERFORMANCE: 150 lbs. in 345-n. mi. orbit; 100 lbs. in 1,600-n. mi. probe; speed over 20,000 fps; range, over 6,000 n. mi. vertical; weight, 35,500 lbs.

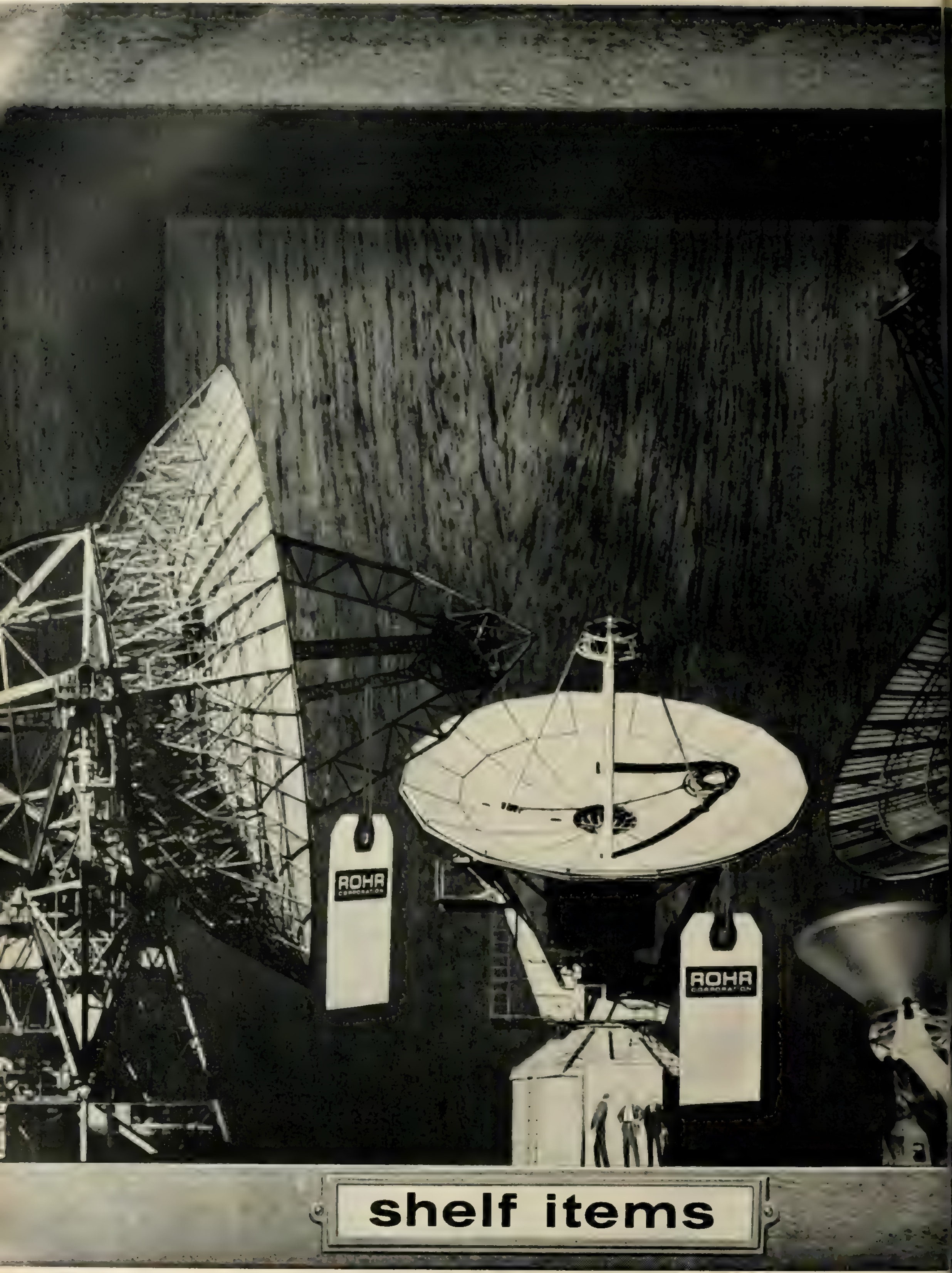
FRAME: Four stages, all solid rockets; length, 75 ft.; diameter, 3.3 ft.

PROPULSION: First stage, Aerojet solid Algol motor with 100,000 lbs. thrust; second stage, Thiokol solid Castor motor with 55,000 lbs. thrust; third stage, Hercules solid Antares motor with 13,000 lbs. thrust; fourth stage, Hercules solid Altair motor with 3,100 lbs. thrust

PAYLOAD: Scientific instrumentation and components related to ballistic missile and space programs

REMARKS: Developed as research vehicles related to NASA's Scout series; other versions of Blue Scout differ in number of stages and are designated Blue Scout I and II

BLUE SCOUT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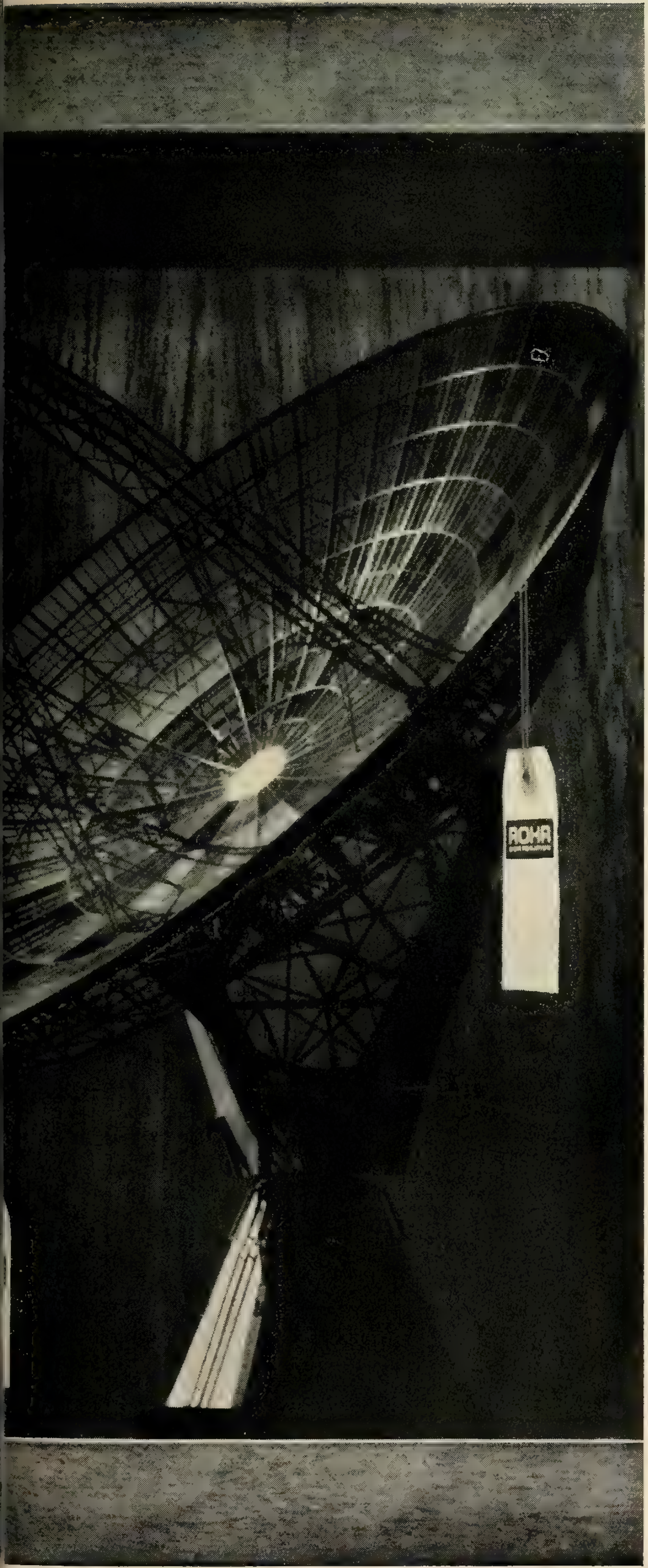
shelf items



Rohr has researched, developed, engineered, built and erected the antennas shown here, along with others. They are among the largest and most precise antenna structures in the nation today. And performance has exceeded customer specifications in every instance.

The unique Rohr capability in the manufacture of this massive, accurate antenna hardware is a natural . . . the application of top antenna talent to a tremendous base of experience in metal forming for the precision production of large aircraft components.

Because of the interdependence of the antenna structure and the servo control and drive, Rohr is ready . . . and actually prefers to furnish fully integrated systems. Both hydraulic and electric drive and control systems have been designed and are available for each antenna structure developed. The antennas shown have been fully engineered and, therefore, represent "off the shelf" economy to Rohr customers, along with short delivery time. Minor modifications can be made to meet individual customer requirements.

All antenna cost quotations reflect the Rohr policy of complete customer service and include design, fabrication, packing, shipping, installation, foundation design, accommodation for RF equipment, field alignment and check-out and acceptance tests to prove performance.

Rohr 85-foot X-Y Antennas (F/D .4) with X band (TO 11 KMC) capability are used as satellite data acquisition trackers. Four have been fabricated . . . the first installed for NASA Goddard Space Flight Center near Rosman, North Carolina, and the second near Fairbanks, Alaska. Preliminary acceptance tests indicate all performance requirements will be met or exceeded.

Rohr 30-foot Az/El Antennas (F/D .4) with K band (TO 33 KMC) capability is a versatile instrument with missions including satellite communications, solar and galactic studies, precise doppler ranging of satellites or planets, missile tracking and telemetry. The first installation has been operational since July, 1962, at the Goldstone Tracking Station near Barstow, California, and all specifications have been exceeded.

Rohr 85-foot Az/El Antennas (F/D .4) with X band (TO 10 KMC) capability are designed for use in solar and galactic studies, precise doppler ranging of satellites or planets and missile tracking. Current Air Force Bahama Islands installation is for the mission of telemetry data.

The above antennas are available with economical mesh surfaces for operation at lower frequencies.

A 15-foot diameter millimeter radio telescope (F/D .3) has been fabricated and is currently being tested at Rohr. With capabilities to 300 GC, over-all operation of the instrument appears to make it the most precise radio telescope for its size in the free world today.

In addition, Rohr is the prime contractor on the 210-foot antenna currently being built for JPL/NASA.

For full information on the Rohr antenna capability and costs, please phone or write: Marketing Manager, Dept. 17 , Rohr Corporation, Chula Vista, California.

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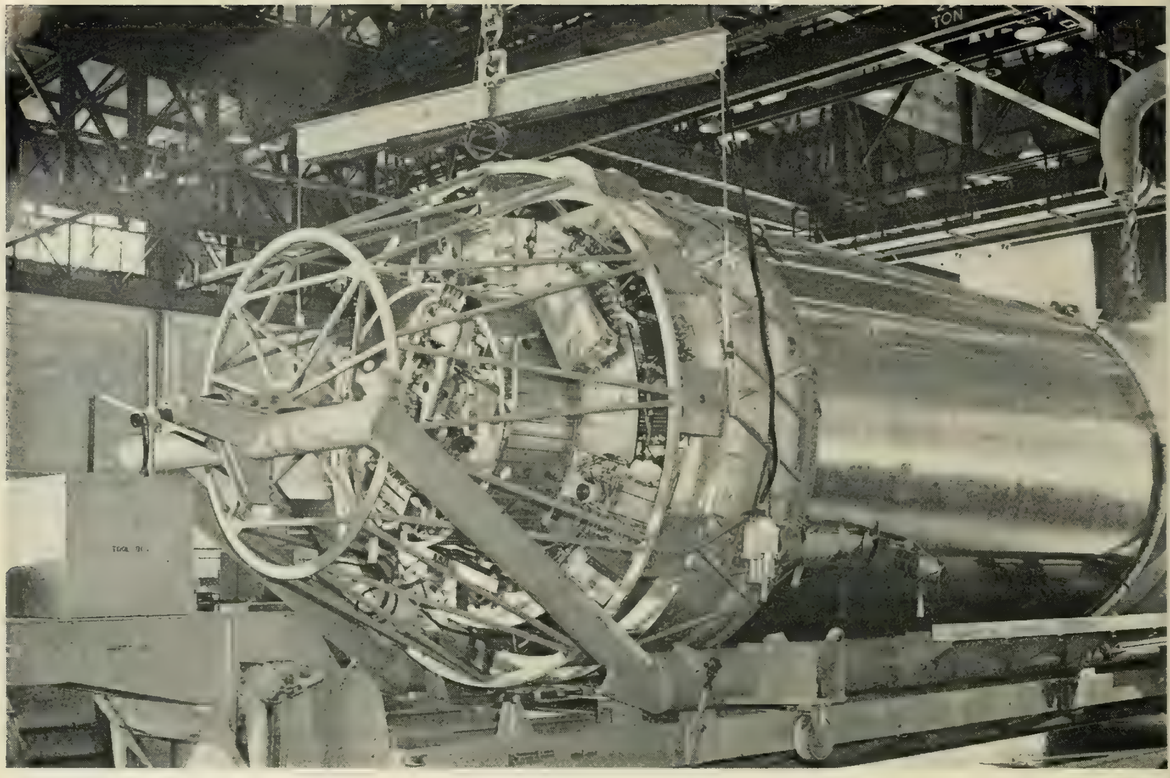


CENTAUR

Centaur (NASA)

TYPE: Multi-purpose upper stage

MISSION: Surveyor and Mariner spacecraft on lunar and interplanetary missions; will also be used as upper stage for a variety of future space missions

STATUS: R&D

PRIME CONTRACTOR: General Dynamics/Astronautics; propulsion—Pratt & Whitney

CONFIGURATION: two RL-10 engines developing 30,000 lbs. total thrust; vehicle will have maximum diameter of 10 ft. and with Atlas booster will be 105 ft. high

GUIDANCE: System contractor—Minneapolis-Honeywell; type—all-inertial

PROPULSION SYSTEM: RL-10 LOX-liquid hydrogen engine, Pratt & Whitney

PAYLOAD: With Atlas D booster, it will place 8,500 lbs. in 345-mi.-high altitude, 2,300 lbs. to escape velocity and 1,300 lbs. on planetary flights

REMARKS: First flight, May 1962, failed when LH_2 tank shielding broke off 54 seconds after launch; second launch now scheduled for third quarter 1963; one more launch in 1963 and five in 1964; operational target date, late 1964, or early 1965; vehicle 18 months to two years behind schedule

Delta (NASA)

TYPE: Launch vehicle for small payloads

MISSION: Launch vehicle for Tiros, Echo, Explorer, Telstar, and other programs

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co.

FRAME: Height 90 ft.; max. dia., 8 ft.

CONFIGURATION: Three stages

GUIDANCE: Bell Telephone Laboratories

PROPULSION: Liquid-solid; first stage, modified Thor (LOX/RP) (SM-75) thrust 170,000 lbs., Douglas; second AJ10-118, (WIFNA/UDMH) Aerojet-General; thrust 7,700 lbs.; Altair, (solid), thrust, 2,800 lbs.; Allegany Ballistic Laboratory

PAYLOAD: 500 lbs. in 345-mi. orbit, 60 lbs. to escape

REMARKS: Vehicle has chalked up 18 straight successful launches; first order in April, 1959, was for 12 Deltas; NASA now has assigned it to more than 30 additional missions

Nova (NASA)

TYPE: Multimillion-lb.-thrust launch vehicle

MISSION: Booster for manned interplanetary flights

STATUS: Under study

PRIME CONTRACTOR: GD/A Martin and Boeing awarded study contracts

PROPULSION SYSTEM: Not determined but combination of solid, liquid and nuclear stages are under consideration

PAYLOAD: Not determined but it would be about 2½ to 3 times the Saturn V payload of 220,000 lbs. in Earth orbit

REMARKS: No program decision expected until 1968 or later; operational target date: about 1975

Little Joe II (NASA)

TYPE: Small solid booster

MISSION: Launch Apollo spacecraft in suborbital test flights

STATUS: R&D

THRUST: Up to 735,000 lbs., but it will vary depending upon number of solid motors and stages used

PRIME CONTRACTOR: General Dynamics/Convair

REMARKS: First flight scheduled for next month; six vehicles ordered; two versions being used; one has one 105,000-lb.-thrust Algol rocket in the first stage and six 34,000-lb.-thrust Recruit rockets in second stage; large version uses seven Algol rockets with a total thrust of 735,000 lbs.

Orion (Air Force)

TYPE: Space propulsion system

STATUS: Feasibility studies and component development

PRIME CONTRACTOR: General Atomics Div., General Dynamics

PERFORMANCE: Capable of placing 1,000 tons in orbit

CONFIGURATON: Classified, but believed to consist of a large energy-absorbing plate or surface mounted on springs behind the vehicle

PROPULSION: Consists of series of small nuclear bombs ejected from rear of vehicle and exploded a short distance behind; energy, both physical and radiative, imparts velocity to vehicle, giving extremely high theoretical specific impulses; feasibility has been proven with high-explosive charges and a sub-scale model, but nuclear test ban agreements hinder further full-scale work

REMARKS: AF's FY '64 request for $9.8 million to continue work was rejected by DOD; AF continuing some work with funds reprogrammed from FY '63; Dr. Jerome Wiesner recommended more work, but funds have been consistently inadequate

Rover (NASA and AEC)

TYPE: nuclear rocket program

MISSION: Superthrust nuclear upper stage to lift heavy payloads on lunar and interplanetary flights

STATUS: R&D

PRIME CONTRACTOR: Lockheed, RIFT flight stage

PROPULSION SYSTEM: Nerva engine—Aerojet; Westinghouse, subcontractor; Kiwi reactor, Los Alamos Scientific Laboratory

REMARKS: First flight scheduled by the end of this decade; program currently has been delayed by inability to finalize reactor design

SATURN IB

Saturn I (NASA)

TYPE: 1.5-million-lb. thrust launch vehicle

MISSION: Boost boilerplate Apollo spacecraft in Earth-orbital flights

STATUS: R&D

PRIME CONTRACTOR: Marshall Space Flight Center; S-1 stage, Chrysler; S-IV stage, Douglas

FRAME: 21.6 ft. wide; 125 ft. high

CONFIGURATION: S-1 stage, eight H-1 engines developing 1.5 million lbs. thrust; S-IV stage, six RL-10AE engines; thrust, 90,000 lbs.

PROPULSION SYSTEMS: All liquid; H-1, LOX-RP, Rocketdyne Div., NAA; A-3 LOX/H_2, Pratt & Whitney Aircraft

PAYLOAD: 20,000 lbs. in 345-mi. orbit

REMARKS: First launch Oct. 27, 1961; second launch April 25, 1962, third launch, Nov. 16, 1962; fourth launch, Mar. 28, 1963; all successful; SA-4, first launch with live second stage expected August 1963; to be operational after 10-vehicle flight-test program in late 1964 or early 1965

Saturn IB (NASA)

TYPE: 1.5-million-lbs. thrust launch vehicle

MISSION: Boost Apollo spacecraft, including lunar landing vehicle, models on Earth-orbital flights; also may be used as a supply vehicle in future programs

STATUS: R&D

PRIME CONTRACTORS: S-1 stage, Chrysler; S-IVB stage, Douglas

FRAME: 21.6 ft. dia., 141 ft. high

CONFIGURATION: S-1 stage, eight H-1 engines total thrust 1.5 million lbs.; S-IVB stage, one J-2 engine 200,000 lbs. thrust

PROPULSION SYSTEM: All liquid; Rocketdyne H-1, LOX/RP; Rocketdyne J-2, LOX/H_2

PAYLOAD: 28,500 lbs. in 345-mile Earth orbit

REMARKS: First flight 1965

Saturn V (NASA)

TYPE: 7.5-million-lb.-thrust launch vehicle

MISSION: Prime booster for the first manned lunar landing mission using the lunar-orbit rendezvous method; under study as booster for space station

STATUS: R&D

PRIME CONTRACTOR: S-IB stage, Boeing; S-II stage, North American; S-IVB stage, Douglas

FRAME: 33 ft. diameter, 275 ft.-high

CONFIGURATION: S-IB stage 5 F-1 engines, total thrust 7.5 million lbs.; S-II stage 5 J-2 engines, total thrust 1 million lbs.; S-IVB stage 1 J-2 engine, total thrust 200,000 lbs.

PROPULSION SYSTEM: All liquid; F-1 liquid oxygen/kerosene engine, Rocketdyne Div. NAA; J-2 liquid hydrogen/liquid oxygen engine, Rocketdyne Div. NAA

PAYLOAD: 220,000 lbs. in 345-mi. Earth orbit; 90,000 lbs. escape; 70,000 lbs. planetary

REMARKS: First flight scheduled for 1966; engines for 10 vehicles already under contract

Scout (NASA)

TYPE: Launch vehicle for small payloads

MISSION: Booster for NASA scientific satellites, electric engine and international satellite programs

STATUS: Operational

PRIME CONTRACTOR: Chance Vought

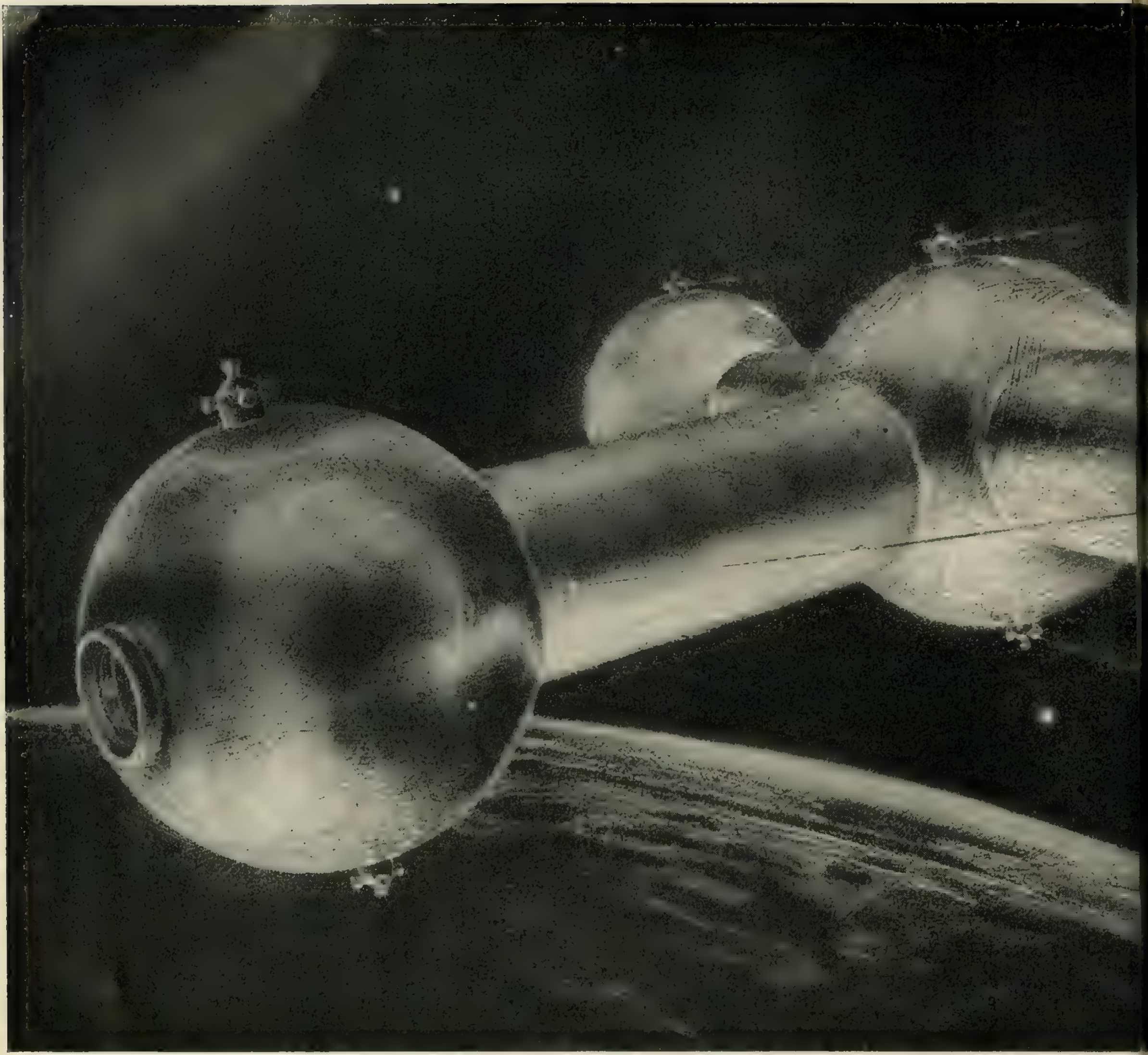
CONFIGURATION: 40 in. maximum diameter, 72-ft. high

GUIDANCE: Minneapolis-Honeywell; type—inertial reference

PROPULSION SYSTEM: All solid; 1st stage, Algol, Aerojet-General; 2nd, Castor, Hercules; 3rd, Antares, ABL; 4th, Altair, ABL

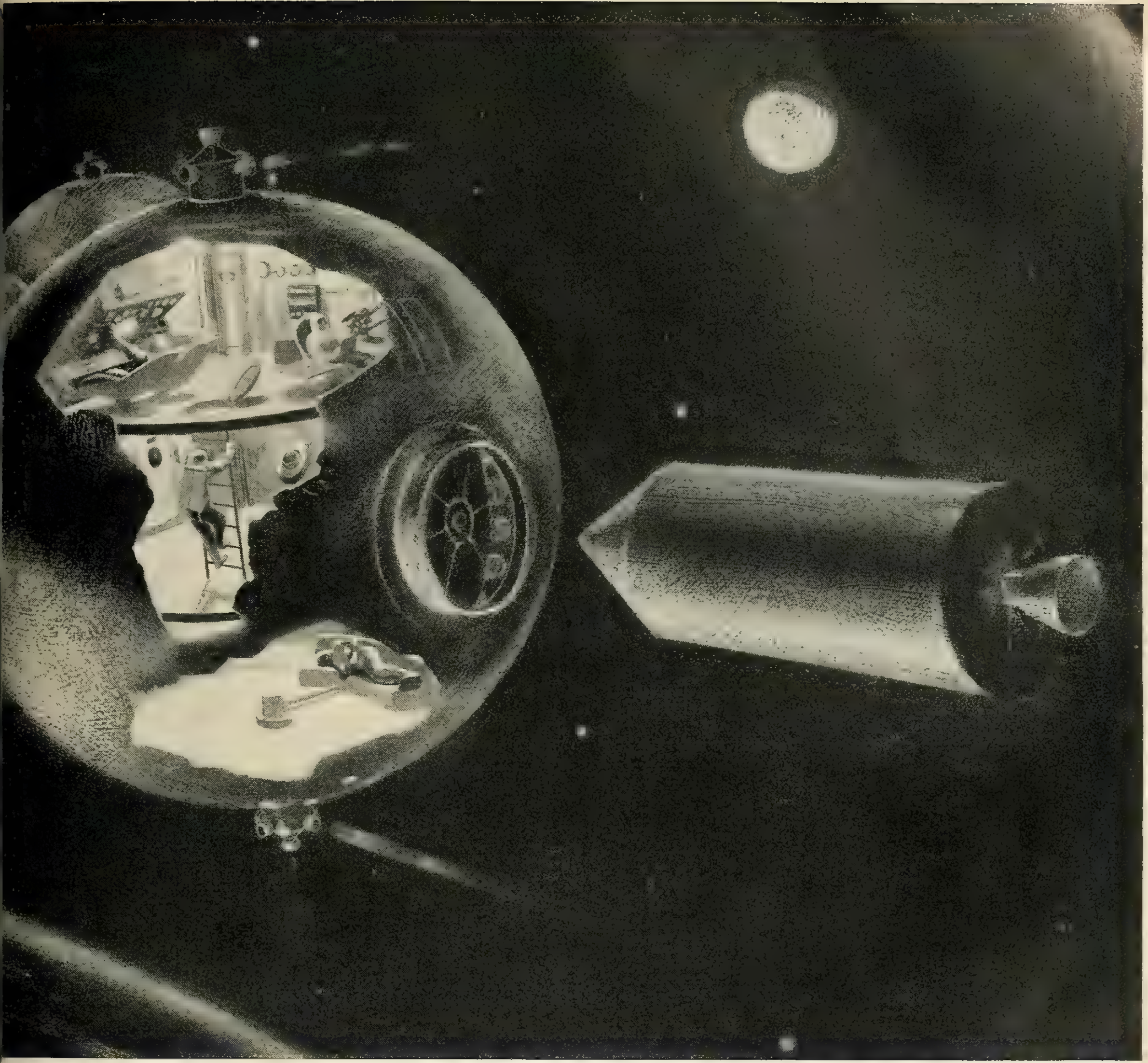
PAYLOAD: More than 200 lbs. in 300-mi. orbit

REMARKS: Vehicle operational; NASA has ordered 23 more



How do you reduce the cost of building a manned space station?

...another complex problem which Douglas and
the aerospace industry are helping NASA solve



A space craft docks in the Douglas designed module of an assembled space station. As crew members go about routine duties, one crewman in the module's lower cabin is gravity-conditioned on a centrifuge.

race for space supremacy is too critical to risk ory by pinching pennies. But the men most conned also know that success depends on squeezing y ounce of value from the dollars and skills invested.

n example of this is a Douglas proposal for a way tilize expended vehicles which will already be in t (like Saturn S-IV and S-IVB tanks) in building e stations from which various space missions could aunched. This method would sharply cut the great ense of launching new components to serve as e living quarters and laboratories. Time and effort ld also be saved.

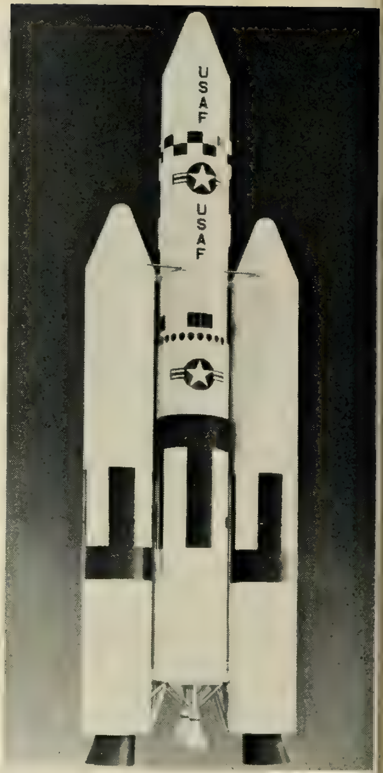
s conceived by Douglas engineers, key element in new technique is the SPACEBALL, a unique modular space vehicle easily boosted aloft. SPACEBALL would be designed to link expended space vehicle stages and dock many types of space craft ...like the Gemini and Apollo capsules.

Any number of these modular units could be joined to provide space stations or even space ships of almost any size that might be needed.

DOUGLAS

Major Douglas Divisions are located in Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

THRUST-AUGMENTED THOR



TITAN III

Thor-Agena (Air Force and NASA)

TYPE: Launch vehicle

STATUS: R&D with Agena B

PRIME CONTRACTOR: None

PERFORMANCE: Agena B—1,600 lbs. in 300-mi. orbit

FRAME: Manufacturers — Douglas, Lockheed; length overall 86 ft.; diameter—8 ft.; gross weight Agena B about 123,000 lbs.; major material—aluminum

PROPULSION: All-liquid

GUIDANCE: (Only Agena B) Minneapolis-Honeywell; type: all-inertial

STAGES: 1-modified Thor IRBM, Douglas 2. Agena, Engine-Bell XLR-81, Bell Aerospace, Agena Vehicle, Lockheed

REMARKS: Used in Air Force Discoverer program; NASA will use it in Nimbus, Echo, OGO, Topside Sounder satellite and other programs; eleven NASA launches scheduled.

Thrust-Augmented Thor (TAT) (Air Force)

TYPE: Improved standard launch vehicle

MISSION: Booster for heavyweight Discoverer and other satellites

STATUS: Operational

CONFIGURATION: Standard Douglas-Thor launch vehicle with three Thiokol solid-propellant rockets to give added thrust; standard thrust for Thor is 170,000 lbs.; added rockets boost total to 330,000 lbs.

REMARKS: TAT, designated SLV IIC, is used by AF to orbit payloads too heavy for the Thor, but which would not utilize all the capacity of Atlas; TAT is believed to be used for orbiting some MIDAS and SAMOS payloads

Titan III (Air Force)

MILITARY DESIGNATION: Program 624A

TYPE: Standard space booster for quick-reaction military missions

STATUS: Development

CONTRACTORS: Martin Co., systems integration; UTC, large solid rockets; Martin Co., Titan II core vehicle; Aerojet, liquid rocket propulsion; AC Spark Plug, guidance

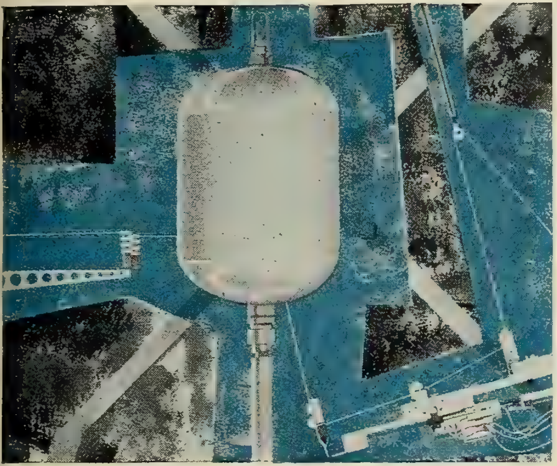
PERFORMANCE: Capable of placing 5,000-20,000 lbs. in low Earth orbits or synchronous orbits, depending on configuration

PROPULSION: Core vehicle—two liquid rocket engines with 430,000 lbs. thrust total; one liquid rocket engine with 100,000 lbs. thrust, and two liquid rocket engines with 8,000 lbs. thrust each; "outboard motors" of two solid rockets, each 120-in.-dia. generating 2,000,000 lbs. thrust total and weighing 500,000 lbs. each

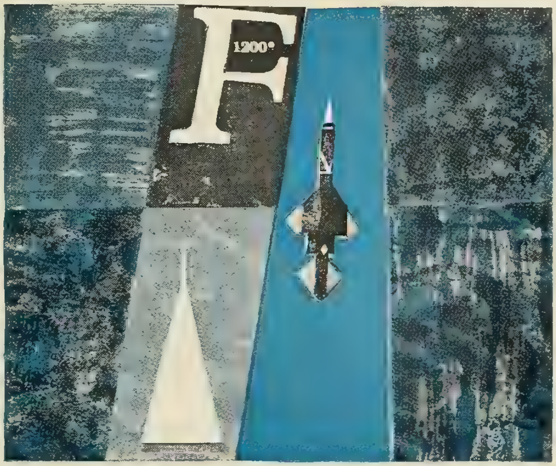
CONFIGURATION: Titan IIIA is core vehicle only (modified Titan II) with third stage; Titan IIIC is full vehicle, using both outboard solid rockets; configuration used depends on mission parameters

REMARKS: First flight of Titan IIIA expected late 1964; first Titan IIIC flight expected January, 1965; 17 development flights planned—5 Titan IIIA and 12 Titan IIIC; booster for X-20 and possibly Gemini

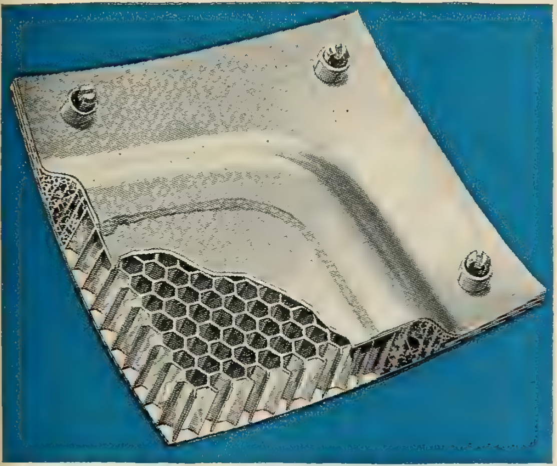
Researched, developed, manufactured and tested . . . in house by Brunswick



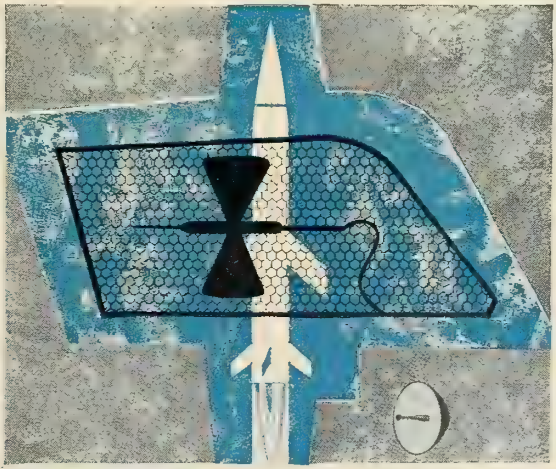
ROCKET MOTOR CASE — Brunswick is a leading designer and fabricator of fiberglass filament wound rocket motor cases. Experience on Polaris A-3 and other programs has resulted in an unexcelled capability for design, fabrication, and test. From the fabrication of the insulator to the final hydrostatic testing of the completed unit, Brunswick can offer a product of utmost reliability.



RADOMES — for supersonic aircraft and missiles. Brunswick's biaxial filament winding process guarantees maximum transmission properties by precise resin control, precision ground wall thickness tolerance of ±.001. Brunswick's electronic test facilities include ten test ranges for pattern studies on all types of antennae with directional pattern characteristics.



HONEYCOMB ASSEMBLIES — Brunswick has complete facilities for the design and fabrication of aluminum sandwich and reinforced plastic components. Large parabolic reflector panels are fabricated to ± .010 contour tolerance. Other sandwich assemblies can be fabricated using a wide variety of adhesives and materials. Brunswick's decade of experience has made it an acknowledged leader in this field.



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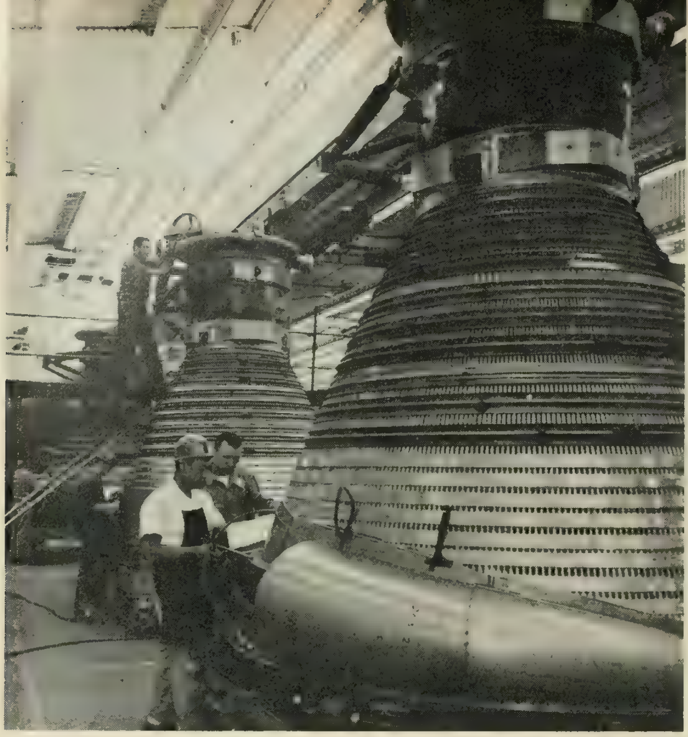


F-1 ENGINE

Engines

Agena

MANUFACTURER: Bell Aerospace Corp.

MANUFACTURER'S NUMBER: XLP-81-BA-5, -7 and -9

PROPELLANTS: RFNA and UDMH

NOZZLE MATERIAL: uncooled titanium

LENGTH: 7 ft.

WIDTH: 3 ft.

WEIGHT: 300 lbs.

START SYSTEM: solid propellant

IGNITION: hypergolic

PROPELLANT SUPPLY: turbopump, single restart

AVERAGE THRUST: 16,000 lbs.

BURNING TIME: tank capacity

STATUS: operational—to be used with OGO, Nimbus and USAF Agena vehicles; also target vehicle for Gemini rendezvous

Atlas Booster

MANUFACTURER: Rocketdyne Div., North American Aviation

MANUFACTURER'S NUMBER: MA-2, MA-3 (booster-LR90 NA-5 sustainer, LR105NAO)

PROPELLANTS: LOX, RP-1

NOZZLE CONFIG. & EXP. RATIO: bell, regen. cooled, 8:1

NOZZLE MATERIAL: nickel

LENGTH: about 8 ft.

WIDTH (MAXIMUM): (one engine) 60 in.

WEIGHT (ONE ENGINE): 1,418 lbs.

START SYSTEM: MA-2-LOX-kerosene gas gan.; MA-3-solid propellant.

IGNITION: MA-2-pyrotechnic; MA-3-pyrophoric

PROPELLANT SUPPLY: turbopump—twin pumps operated by single turbine for each chamber

AVERAGE THRUST: MA-2—370,000 lbs. MA-3—389,000 lbs. at sea level

BURNING TIME: 120 sec.

STATUS: Atlas missile, Atlas Agena, Atlas Centaur

Delta—Second Stage

MANUFACTURER: Aerojet-General

MANUFACTURER'S NUMBER: AJ10-118

PROPELLANTS: IRFNA and UDMH

LENGTH: 190 in.

WIDTH (MAXIMUM): 32 in.

WEIGHT: 645 lbs.

IGNITION: hypergolic

PROPELLANT SUPPLY: pneumatically pressurized tanks

AVERAGE THRUST: 7,500 lbs.

BURNING TIME: tank capacity

STATUS: Thor-Delta scientific satellite launch vehicle

F-1

MANUFACTURER: Rocketdyne Div., North American Aviation

MANUFACTURER'S NUMBER: F-1

PROPELLANTS: RP-1, LOX

NOZZLE CONFIG. & EXP. RATIO: mod. bell, more than 12:1, regen. cooled

LENGTH: about 20 ft.

WIDTH: about 12 ft.

WEIGHT: about 20,000 lbs.

START SYSTEM: solid propellant

IGNITION: electric spark

PROPELLANT SUPPLY: turbopump

AVERAGE THRUST: 1.5 million lbs.

SPECIFIC IMPULSE, SEA LEVEL: about 260 sec.

BURNING TIME: tank capacity

STATUS: originally intended for Nova, and slated for Saturn V in a cluster of 5 engines

H-1 Engine

MANUFACTURER: Rocketdyne Div., North American Aviation

MANUFACTURER'S NUMBER: H-1

PROPELLANTS: LOX, Kerosene

NOZZLE CONFIG. & EXP. RATIO: bell, 8:1, regen. cooled

NOZZLE MATERIAL: nickel

LENGTH: about 8 ft.

WIDTH: (Maximum): 50 in.

WEIGHT: about 1,400 lbs.

START SYSTEM: solid propellant

IGNITION: pyrophoric

PROPELLANT SUPPLY: turbopump

AVERAGE THRUST: 188,000 lbs.

SPECIFIC IMPULSE, SEA LEVEL: 255 sec.

BURNING TIME: tank capacity

STATUS: cluster of 8 for Saturn I and IB

J-2

MANUFACTURER: Rocketdyne Div., North American Aviation

MANUFACTURER'S NUMBER: J-2

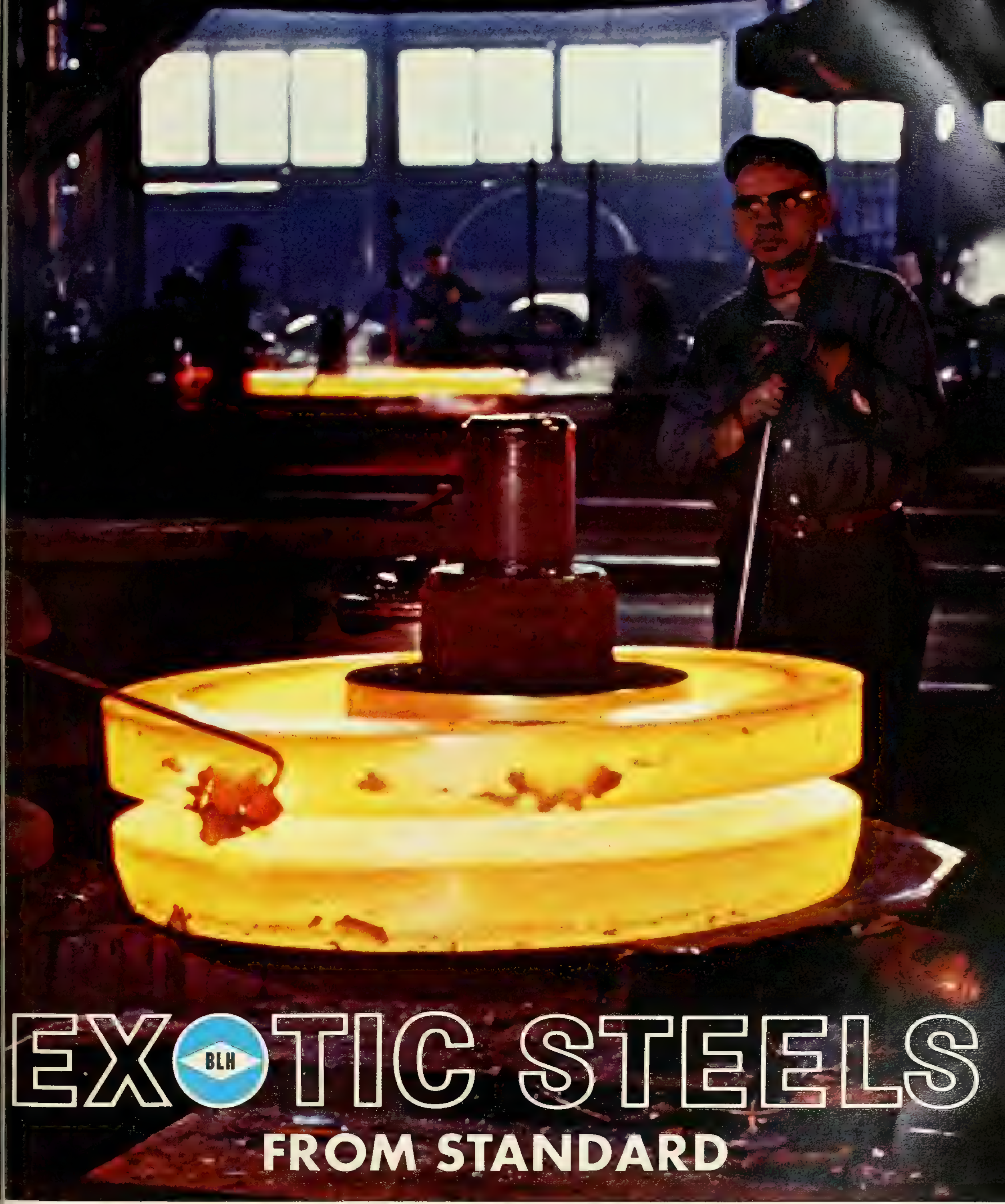
PROPELLANTS: LOX, liquid hydrogen

AVERAGE THRUST: 200,000 lbs.

SPECIFIC IMPULSE, SEA LEVEL: not released

BURNING TIME: tank capacity

STATUS: slated for Saturn IB and V



The ring's the thing. Basic to every industry. Standard produces these weldless annular forgings in a wide variety of metals, alloys, sizes and configurations to your specifications.

Two examples are shown above—a specially shaped high alloy ring being rolled on a custom-designed rolling mill in the foreground and a large missile ring on a mill in the background.

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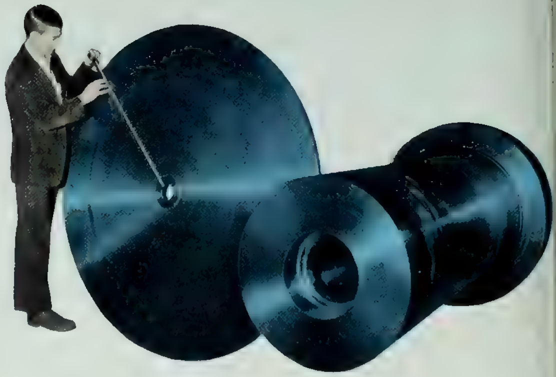
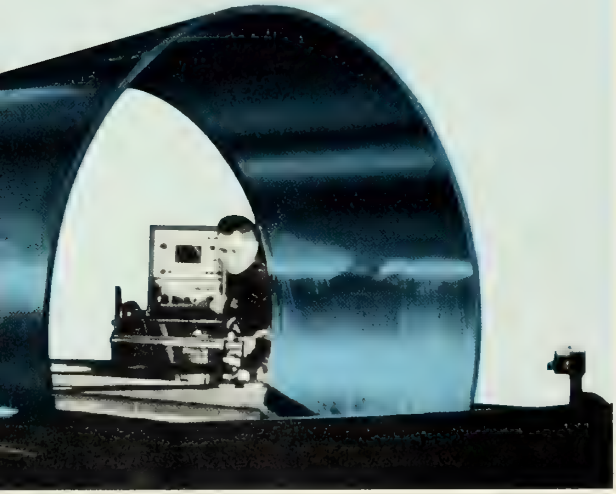
Minuteman missile motor casing of high-alloy vacuum arc remelt steel is checked for dimensional accuracy. Huge gear rings at rear are cast carbon steel.

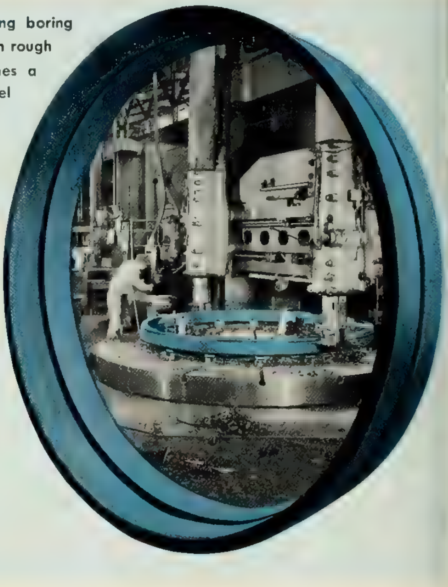


18% nickel maraging steel preform for Pershing missile motor case and Inconel stator shell for pump housing.

Immersion sonic testing provides the ultimate in quality control of Minuteman missile motor casings and other critical components.



Modern 14-ft. swing boring mill viewed through rough rolled rings machines a huge weldless steel bearing ring.



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BLH

3-63-2

Printed in U.S.A.

M-1

MANUFACTURER: Aerojet-General

PROPELLANTS: LOX, liquid hydrogen

NOZZLE: upper stage DeLaval type, gas cooled

START SYSTEM: gas generator

IGNITION: electric spark

PROPELLANT SUPPLY: dual turbopumps (one per propellant); fuel pump is a two-stage unit.

THRUST: 1.5 million lbs.

STATUS: first static test tentatively slated for late 1964, PFRT in 1967 and first flight in 1969 at the earliest

Nerva

MANUFACTURER: Aerojet-General

PROPELLANTS: gaseous hydrogen

NOZZLE: regen. cooled

IGNITION: passing liquid hydrogen through the nuclear reactor heats the propellant which is then expended through the nozzle

PROPELLANT SUPPLY: turbopump

SPECIFIC IMPULSE, SEA LEVEL: should be in the 800-sec. area

STATUS: development with flight tests scheduled prior to 1970; NERVA engine will be on a RIFT (Reactor in Flight Test) vehicle; reactor is under contract to Westinghouse; RIFT being built by Lockheed

RL-10

MANUFACTURER: Pratt & Whitney

MANUFACTURER'S NUMBER: RL-10

PROPELLANTS: LOX, liquid hydrogen

NOZZLE CONFIG. & EXP. RATIO: mod. bell, 40:1

IGNITION: exciter-spark

PROPELLANT SUPPLY: bootstrap-hydrogen gas driven turbopump

AVERAGE THRUST: 15,000 lbs.

SPECIFIC IMPULSE, SEA LEVEL: approx. 425 sec.

BURNING TIME: tank capacity

STATUS: multiple start upper-stage propulsion system intended for major space missions. (See Centaur Launch Vehicle and Saturn V)

Titan I Booster

MANUFACTURER: Aerojet-General

MANUFACTURER'S NUMBER: LR-87-AJ-3

PROPELLANTS: LOX, Kerosene

NOZZLE CONFIG. & EXP. RATIO: bell, 8:1, regen. cooled

NOZZLE MATERIAL: nickel

LENGTH: about 10 ft.

WIDTH (MAXIMUM): about 9 ft.

WEIGHT: about 3,700 lbs.

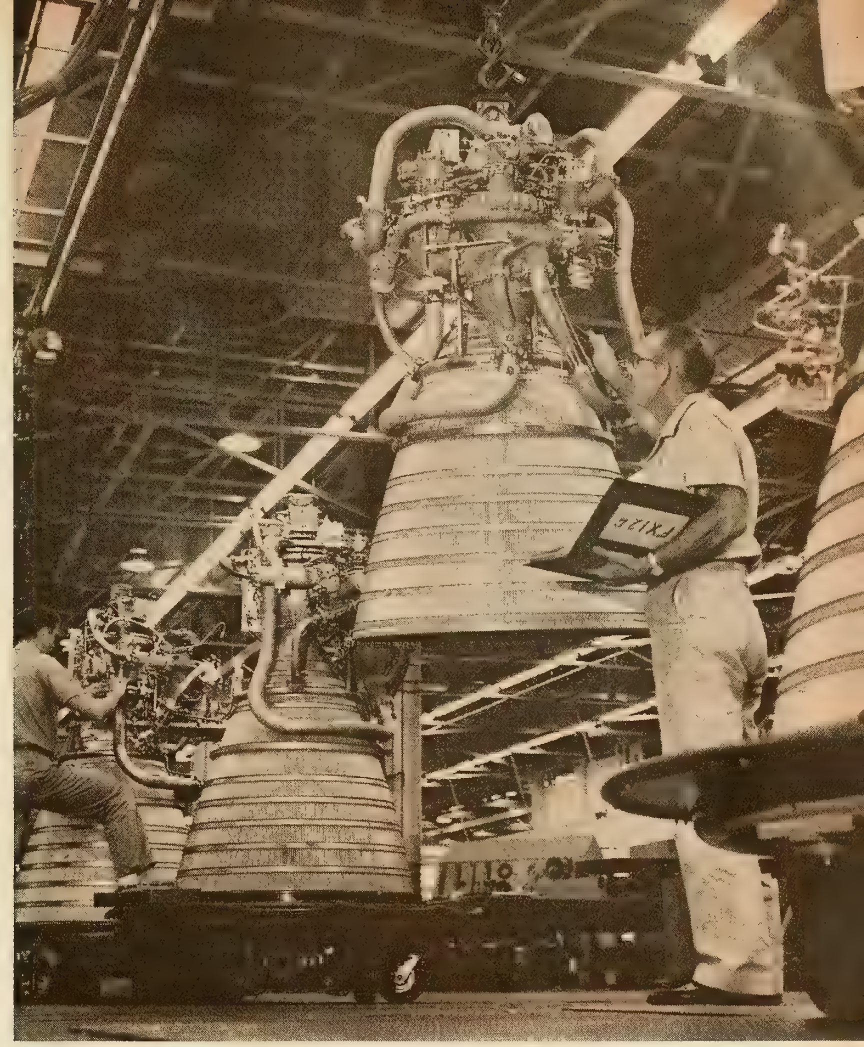
START SYSTEM: ground-supplied

IGNITION: pyrotechnic

PROPELLANT SUPPLY: turbopump

AVERAGE THRUST: 30,000 lbs.

BURNING TIME: 120 sec.



RL-10 ENGINE

Titan II-1st Stage

MANUFACTURER: Aerojet-General

MANUFACTURER'S NUMBER: YLR-87-AJ-5

PROPELLANTS: nitrogen tetroxide, Aerozene-50 (50-50 mixture UDMH & hydrazine)

NOZZLE CONFIG. & EXP. RATIO: bell, regen. cooled, 8:1

START SYSTEM: bootstrap

IGNITION: hypergolic

PROPELLANT SUPPLY: turbopump

AVERAGE THRUST: 430,000 lbs. (two barrel)

BURNING TIME: tank capacity

Titan II—2nd Stage

MANUFACTURER: Aerojet-General

MANUFACTURER'S NUMBER: YLR-91-AJ-5

PROPELLANTS: nitrogen tetroxide, Aerozene-50

NOZZLE CONFIG. & EXP. RATIO: mod. bell, 45:1, regen. cooled

START SYSTEM: bootstrap

IGNITION: hypergolic

PROPELLANT SUPPLY: turbopump

THRUST: 100,000 lbs.

BURNING TIME: tank capacity

Titan III—Engines

MANUFACTURER: Aerojet-General

REMARKS: Titan II engines used in modified form; principal changes are in upper altitude capabilities for the YLR-87-AJ-5 and the incorporation of a malfunction detection system

Titan III—Transtage

MANUFACTURER: Aerojet-General

PROPELLANTS: storable, nitrogen tetroxide, Aerozene-50

START SYSTEM: gas pressurized system

IGNITION: hypergolic

THRUST: 16,000 lbs. total; 8,000 lbs. from each of the twin barrels

REMARKS: capable of start/stop operation in zero-g environment; engine has ablative chambers and titanium exhaust skirt; engine is slated to provide orbital changes for Titan III payloads

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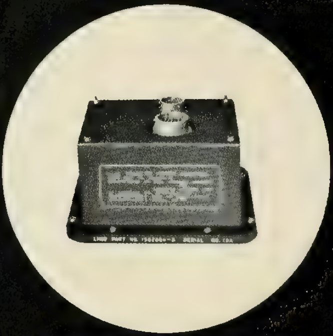

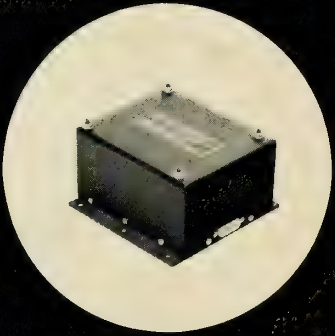

MILLIWATT RESET COUNTER:

- capacity 2^{18} counts.
- counting rate 0 to 100,000/sec.
- input scaler ratios from 1:1 to 32:1, electrically selectable.
- pre-flight and in-flight preset by telemetered code.
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- Qual-tested by DI/AN.

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- 30,096 bit sequential access memory.
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- 20 ozs., 10,296 bit unit also available.
- Qual-tested by DI/AN.

***HISTORY:** NO ONE (repeat, no one) comes close to matching DI/AN's history of reliability in magnetic logic equipment for space. Proof: The operating history of these devices (and their predecessors) approaches a million hours in over 30 different aerospace programs with no known failure.

RELIABILITY: This, mind you, is a record of actual use of our clocks, timers, counters, miniature memories, etc. The record is supported by two life tests of the individual magnetic Core-Transistor Logic modules (CTL's), with which these equipments are made. The Tests have logged 3½ million module hours over 5 years — no failures, and 1½ million module hours over 2 years — no failures. These numbers are for complete logic elements — but compare them with numbers for single components!

THE KEY to this history and reliability: The unique advantages inherent in CTL magnetic logic design: low power, few components, non-critical semiconductor parameters, no incremental flux states, resistance to radiation and to extreme temperatures. Plus, extraordinarily high, fully cabled circuit density. (Over 10,000 high-logic-power CTL's per cubic foot.) 1000 CTL's make a parallel GP computer.

SHORT DELIVERY: One type of magnetic logic element is used for all functions — function determined by interconnections. New equipments are built with almost no electrical engineering time required. Product line units illustrated above are available on short delivery from current production.

WRITE FOR DATA SHEETS and special report on "MAGNETIC LOGIC IN SPACE — A REPORT ON HISTORY AND RELIABILITY".

ALSO AVAILABLE: Literature covering three other DI/AN product areas ■ Magnetic Logic and Register Modules and cards ■ Standard Core Memories ■ Data Systems.

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U.S. Research and Sounding Rockets

(Listed under system contractor: manufacturer's nomenclature, type, stages and thrust, launch weight and overall length, performance, remarks, and using organizations.)

Aerolab Development Co.

ARGO A-1 (PERCHERON) Single-stage solid research rocket; Thiokol TX-33 w/two Thiokol TX-77's (150,000-lb. thrust); 10,335 lb., 21.25 ft.; 500-lb. payload to altitude of 200 mi., Mach 8.75; NASA/AF.

ARGO B-1 Two-stage solid sounding rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Cajun (9,600-lb. thrust); 1,540 lb., 23 ft.; 40-lb. payload to altitude of 100 mi.; NASA/AF.

ARGO C-21 Three-stage solid sounding rocket; 1st—Thiokol TX-33-41 (150,000-lb. thrust), 2nd—Hercules X-259 (19,000-lb. thrust), 3rd—United Tech. Ctr. FW3 (thrust classified); 13,620 lb., 50.0 ft.; 250-lb. payload to altitude of 1,250 mi., Mach 19; in development for AF.

ARGO C-22 Three-stage solid sounding rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 *Nike* (48,700-lb. thrust each); 6,950 lb., 43.6 ft.; 212-lb. payload to altitude of 120 mi., Mach 6; uses swept-back stabilization fins; AF.

ARGO C-23 Three-stage solid sounding or research rocket, 1st—Thiokol TX-33 w/two Thiokol TX-77's (150,000-lb. thrust), 2nd—Thiokol TX-261 (40,000-lb. thrust), 3rd—Thiokol TX-239 (29-in. dia. spherical); 14,300 lb., 41.3 ft.; 150-lb. payload to altitude of 2,000 mi., Mach 21; in development for AF.

ARGO D-4 (JAVELIN) Four-stage solid research rocket, 1st—Hercules M-6 *Honest John* (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 Nike (48,700-lb. thrust each), 4th—Hercules X-248 (3,150-lb. thrust); 7,400 lb., 48.7 ft.; 100-lb. payload to altitude of 550 mi.; NASA/AF

ARGO D-8 (JOURNEYMAN A) Four-stage solid research rocket; 1st—Thiokol XM-20 (Sergeant motor) w/two Thiokol 1.5KS3500 Recruits (140,000-lb. thrust), 2nd & 3rd—Lockheed Lance (47,000-lb. thrust each), 4th—Hercules X-248 (3,150-lb. thrust); 14,000 lb., 62.0 ft.; 135-lb. payload to altitude of 1,260 mi.; Mach 24; holds record for highest altitude (1,260 mi.) for recovered payload; NASA.

ARGO E-5 (JASON) Five-stage solid sounding rocket, 1st—Hercules M-6 *Honest John* (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 Nike (48,700-lb. thrust each), 4th—Thiokol TX-77 (42,350-lb. thrust), 5th—Thiokol T-55 (4,650-lb. thrust); 7,250 lb., 56.5 ft.; 50-lb. payload to altitude of 500 mi., Mach 12.5; AF.

TRAILBLAZER I Six-stage (incl. three downward-thrust packaged in reverse in 3rd stage) solid research rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd—Hercules M-5 Nike (48,700-lb. thrust), 3rd—either Lockheed Lance (47,000-lb. thrust) or Thiokol TX-77 (42,300-lb. thrust), 4th—Thiokol T-40, 5th—Thiokol T-55 (4,650-lb. thrust), 6th—NASA/Langley 5-in. spherical motor; 7,500 lb., 56 ft.; three stages up to altitude of 200 mi., three stages down attain 24,000 fps. (a "gun-fired" pellet fired downward has reached 35,000 fps.); NASA.

American Machine and Foundry Co.

PURR KEE, ADVANCED Two-stage sounding rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Hercules X-220 (6,400-lb. thrust); 6 ft.; in development for Navy.

Atlantic Research Corp. (ARC)

ARCAS Single-stage solid sounding rocket; ARC 29KS-336; 65 lbs., 6.6-9.1 ft.; 10-lb. payload to altitude of 50 mi.; all services and NASA.

ARCAS, BOOSTED Single-stage solid sounding rocket, ARC 1KS-2200; 110 lbs., 9.7-12.2 ft.; 10-lb. payload to altitude of 70 mi; all services and NASA.

ARCHER Single-stage solid sounding rocket, ARC 35KS-1375; 330 lbs., 12.8 ft.; 40-lb. payload to altitude of 90 mi.; all services and NASA.

ATHENA Four-stage research rocket; 1st—Thiokol XM-33 w/two Thiokol XM-19's, (142,000-lb. thrust), 2nd—either Hercules X-259 (19,000-lb. thrust) or Thiokol TX261 (40,000-lb. thrust) depending on trajectory requirements; 3rd—Aerojet 30KS-8000; 4th—Hercules BE-3; 16,000 lbs., 50 ft.; 50-300-lb. payload to altitude of 200-50 mi.; two stages up, fin stabilized; two stages down w/guidance in 3rd stage, re-entry angles from 20-45°, re-entry velocities vary with payload from 23,000-16,000 fps; in development for advanced re-entry research and plasma-sheath studies; AF/ARPA.

HONEST JOHN-NIKE-NIKE Three-stage solid sounding rocket; 1st—Hercules M6 Honest John (86,000-lb. thrust), 2nd and 3rd—Hercules M-5 Nike (48,700-lb. thrust); 6,500 lbs., 47 ft.; 250-lb. payload to altitude of 135 mi.; Army/AF/NASA.

HYDRA-IRIS Two-stage solid sounding rocket, 1st—three Aerojet Sparrow 1.8-KS-7800 (22,400-lb. thrust), 2nd—ARC 52KS-4375; 1,350 lbs., 24 ft.; 100-lb. payload to altitude of 200 mi.; all services and NASA.

IRIS Single-stage solid sounding rocket, ARC 52KS-4375; 1,350 lbs., 24 ft.; 100-lb. payload to altitude of 200 mi.; all services and NASA.

METROC Single-stage solid sounding rocket, ARC 16KS-140; 15 lbs., 4.6 ft.; 2-lb. payload to altitude of 20 mi.; all services and NASA.

METROC, BOOSTED Two-stage solid sounding rocket; 1st—ARC Metroc 16KS-140, 2nd—2.75 FFAR (Navy rocket, 720-lb. thrust); 26 lbs., 8.8 ft.; 2-lb. payload to altitude of 52 mi.; all services and NASA.

NIKE-APACHE Two-stage solid sounding rockets; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Apache (5,900-lb. thrust); 1,550 lbs., 23 ft.; 50-lb. payload to altitude of 130 mi.; all services and NASA.

NIKE-ARCHER Two-stage solid sounding rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—ARC *Archer* 35KS-1375; 1,650 lbs., 25 ft.; 40-lb. payload to altitude of 230 mi.; all services and NASA.

NIKE-CAJUN Two-stage solid sounding rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Cajun (9,600-lb. thrust); 1,550 lb., 23 ft.; 50-lb. payload to altitude of 100 mi.; all services and NASA.

SWIK Two-stage solid research rocket; 1st—Thiokol Castor XM-33 (53,850-lb. thrust), 2nd—Hercules X-254 (14,000-lb. thrust); 13,200 lbs., 35 ft.; 300-lb. payload to altitude of 675 mi. Army/AF.

TRAILBLAZER II Four-stage solid research rocket; 1st—Thiokol Castor XM-33 with two Thiokol Recruit XM-19's (142,000-lb. total thrust), 2nd—Lockheed Lance (47,000-lb. thrust), 3rd—Hercules Altair X-248 (3,100-lb. thrust), 4th—ARC/NASA 15-in. spherical (5,000-lb. thrust); 13,344 lbs., 50 ft.; two stages up, two stages downward to achieve re-entry velocity of 22,000 fps; NASA/Army/AF.

Hercules Powder Co.

DEACON (POGO-HI) Single-stage Hercules X-220 solid motor (6100-lb. thrust); 155 lbs., 9.2 ft.; payload weight vs. altitude varies with each program; Army/Navy/NASA/ARPA.

The Marquardt Corp.

ASP I Single-stage Marquardt 5.3KS-5800 solid motor; 216.5 lbs., 8.9 ft.; 50-lb. payload to altitude of 35 mi.; max. acceleration 58 g; Navy.

ASP IV Single-stage Marquardt 12.7KS-2750 solid motor; 208 lbs., 8.9 ft.; 50-lb. payload to altitude of 50 mi.; max. acceleration 20 g; Navy.

ASPAN 150 Two-stage solid sounding rocket; 1st—Hercules M5 Nike (48,700-lb. thrust), 2nd—Marquardt *Asp-I*; 1,503.0 lbs., 21 ft.; 50-lb. payload to altitude of 150 mi.; max. acceleration 53 g; AF (NASA also used vehicle but is phasing it out).

ASPAN 300 Two-stage solid sounding rocket; 1st—Hercules M5 Nike (48,700-lb. thrust), 2nd—Marquardt *Asp-IV*; 1,491.5 lbs., 21 ft.; 50-lb. payload to altitude of 200 mi.; max. acceleration for 60-lb. payload 41 g; Navy.

ROKSONDE 200 Single-stage Marquardt A-1 solid motor (2,000-lb. thrust); 32.5 lbs., 12 ft.; 10-lb. payload to altitude of 200,000 ft. (chaff, parachute, or instrumentation); max. acceleration 120 g; AF/Army/NASA and Italian govt.

ROKSONDE 250 Single-stage Marquardt A-1 solid motor (2,500-lb. thrust); 32.5 lbs., 12 ft.; 10-lb. payload to altitude of 300,000 ft. (chaff, parachute, or instrumentation); max. acceleration 120 g; under company development.

Rocketdyne Div., North American Aviation, Inc.

AEOLUS I-90 Single-stage solid sounding rocket (315-lb. thrust); 41 lbs., 4.25 ft.; 6-lb. payload to altitude of 90,000 ft.; launched from 5-in. gun or reinforced plastic shipping container; Navy.

AEOLUS I-200 Single-stage solid sounding rocket (500-lb. thrust); 69.6 lbs., 7.39 ft.; 6-8 lb. payload to altitude of 200,000 ft.; Navy.

Rocket Power, Inc. (RPI)

JUDI-BALLOON DART Single-stage RPI 1.9KS-2100 Judi-I solid motor; 33.7 lbs., 9 ft.; 10-lb. payload (std. AF Mylar Robin balloon) to altitude of 215,000 ft.; all services.

JUDI-CHAFF DART Single-stage RPI 1.9KS-2100 Judi-I solid motor; 30.3 lbs., 8.6 ft.; 10-lb. payload to altitude of 240,000 ft.; all services and NASA.

JUDI-INSTRUMENTED DART Single-stage RPI 1.9KS-2100 Judi-I solid motor; 33.7 lbs., 9 ft.; 10-lb. payload to altitude of 215,000 ft.; all services and NASA.

KISHA-JUDI Two-stage solid sounding rocket; 1st—RPI Kisha-I, 4.4KS-4800; 2nd—RPI *Judi-III*, 1.9KS-2100; 221-lbs., 14 ft.; 16-lb. payload to altitude of 480,000 ft.; Sandia Corp.

METEOR Three-stage solid research rocket; 1st—Hercules M5 Nike (48,700 lb. thrust); 2nd—RPI Gila-III, 3.1KS-21,300; 3rd—RPI Hopi-I 3.0KS-4000; 1885 lbs., 31 ft.; 3rd-stage re-entry velocity 12,000 fps with 10-lb. payload from 450,000 ft.; under company development.

ORIOLE Single-stage RPI 5.5KS-6100 Kiva-I solid motor; 236 lbs., 13.6 ft.; 10-lb. payload to 473,000 ft. (2-in. dia. Dart with 81.5-cu.-in. payload volume); all services.

PHOENIX Two-stage solid sounding rocket; 1st—RPI Kiva-I 5.5KS-6100, 2nd—RPI Hopi-I 3.0KS-4000; 320 lbs., 18 ft.; 10-lb. payload to altitude of 225 mi.; all services.

RAVEN Single-stage RPI 9KS-1650 solid motor; 100 lbs., 10.8 ft.; 10-lb. payload to altitude of 250,000 ft.; under development for meteorological use by all services and NASA.

THUNDERBIRD Single-stage RPI 15KS-4800 solid motor; 445 lbs., 16 ft.; 35-lb. payload to altitude of 620,000 ft.; under development for Navy.

Space-General Corp.

AEROBEE 100 Two-stage sounding rocket; 1st—liquid IRFNA & JP-4 engine (2,600-lb. thrust for 40 sec.), 2nd—solid Aerojet 2.5KS-18,000; 1,400 lbs.; 25.75 ft.; 70-lb. payload to altitude of 80 mi.; tower launched; max. acceleration 15.2 g; NASA/AF.

AEROBEE 150 & 150A Two-stage sounding rocket; 1st—liquid IRFNA & aniline-furfuryl-alcohol mixture engine (4,100-lb thrust for 51.8 sec.), 2nd—solid Aerojet 2.5KS-18,000; (150) 1,943 lbs., 29.67 ft., (150A) 1,941 lbs., 30.00 ft.; 150-lb. payload to altitude of 152 mi.; max acceleration 10.3 g; tower-launched; 150 has 3 fins, 150A has 4 fins; NASA/AF/Navy.

AEROBEE 300 & 300A Two-stage sounding rocket; 1st—Aerobee 150 or 150A, 2nd—solid Aerojet Sparrow 1.8KS-7800; 2,103 lbs., (300), 33.00 ft., (300A) 33.30 ft.; 35-lb. payload to altitude of 300 mi.; max. acceleration 63.8 g; 300A has 4 fins; NASA/AF.

AEROBEE 350 Design goal 150-lb. payload to altitude of 300 mi.; under development for NASA (5 to be built during FY '64).

ASTROBEE 200 Two-stage solid sounding rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Aerojet 30KS-8000; 2,601 lbs. 26.42 ft.; 150-lb. payload to altitude of 170 mi.; max. acceleration 18.9 g; boom-launched; NASA/AF.

ASTROBEE 250 Two-stage solid sounding rocket; 1st—Two Thiokol 1.5KS-35,000, 2nd—Aerojet 28KS-57,000; 10,358 lbs. 34.17 ft.; 400-1000-lb. payload to altitudes between 120-190 mi.; max. acceleration 13 g; boom-launched; NASA/AF/NAVY.

ASTROBEE 1500 Two-stage solid sounding rocket; 1st—Aerojet 28KS-57,000 with two Thiokol 1.5KS-35,000, 2nd—Aerojet 30KS-8000; 11,493 lbs., 34.17 ft.; 130-lb. payload to altitude of 1,300 mi.; max. acceleration 37 g; boom launched; under development for NASA/AF (replacement for NASA Journeyman A).

University of Michigan

EXOS, ADVANCED Three-stage solid sounding rocket; 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd—Hercules M-5 Nike (48,700-lb. thrust), 3rd—Thiokol TX-77 (42,350-lb. thrust); 5,750 lbs.; 41 ft.; 40-lb. payload to altitude of 200 mi.; NASA/AF.

STRONG ARM Five-stage solid sounding rocket; 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd and 3rd—Hercules M-5 Nike (48,700-lb. thrust each), 4th—Thiokol TX-77 (42,350 lb. thrust), 5th—Thiokol modified XM-33; 7,125 lbs., 56 ft.; 15 lb. to altitude of 1,050 mi.; in development for NASA/Army.

Langley Research Center, NASA

METEOR SIMULATION VEHICLE (1) (Modified Trailblazer II). Four-stage solid research rocket; 1st—Thiokol Castor XM-33 w/two Thiokol Recruit XM-19's (142,000-lb. total thrust), 2nd—Lockheed Lance (47,000-lb. thrust), 3rd—Hercules Altair X-248 (3,100-lb. thrust), 4th—Atlantic Research Corp. spin stabilized velocity package; NASA Cygnus-15 (4,300-lb. thrust, 15-in. dia. spherical), NASA Cygnus-5 (550-lb. thrust, 5-in. dia. spherical), Army Ballistics Research Lab. shaped-charge accelerator and re-entry pellet; 13,500 lbs., 51.5 ft., two stages up to 215-km. altitude, remainder packaged in reverse to achieve 20 km/sec. re-entry velocity 20° off vertical at 70 km. altitude; NASA.

METEOR SIMULATION VEHICLE (2) (Modified Nike-Cajun). Three-stage solid research rocket; 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Cajun (9,600-lb. thrust), 3rd—Zimmey Corp. spin stabilized velocity package: two NASA Cygnus-5 (550-lb. thrust, 5-in. dia. spherical) each associated with an Army Ballistics Research Lab. shaped-charge accelerator and re-entry pellet; 1,575 lbs., 27.5 ft.; two stages up, first re-entry pellet fired downward at 10 km/sec. from 130-km. altitude, second 20 sec. later at 11 km/sec. from 115-km. altitude, both at 20° off vertical; NASA.

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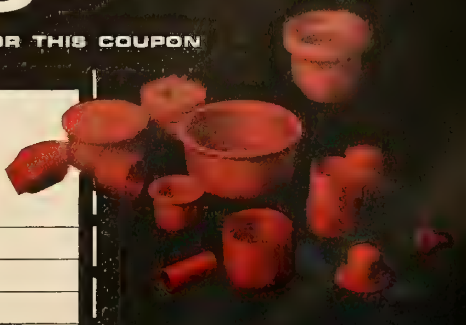

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Satellites in Orbit

EXPLORER I (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years; orbits Earth; perigee 301 km, apogee 1698 km, period 104.9 min.; not transmitting

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. In orbit around Sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

VANGUARD II (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth; perigee 568 km, apogee 3274 km, period 125.2; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun on 398 day cycle; apogee 1.142 au, perigee 0.9871 au; not transmitting.

VANGUARD III (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 516 km, apogee 3721 km, period 129.7; not transmitting.

EXPLORER VII (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 574 km, apogee 1053 km, period 101.1; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 312 day period; aphelion 0.995 au, perihelion .8061 au, not transmitting.

TIROS I (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; perigee 702 km, apogee 737 km, period 99.1; not transmitting.

TRANSIT IB (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 349 km, apogee 614 km, period 94.2. Not transmitting.

MIDAS II (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits Earth; perigee 470 km, apogee 503 km, period 94.2. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits Earth, perigee 616 km, apogee 1054 km, period 101.6. Not transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 620 km, apogee 1048 km, period 101.6. Not transmitting.

ECHO I (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 1072 km, apogee 1853 km, period 115.1.

COURIER IB (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 975 km, apogee 1204 km, period 106.9. Not transmitting.

EXPLORER VIII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 402 km, apogee 2271 km, period 112.3. Not transmitting.

TIROS II (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 629 km, apogee 720 km, period 98.2. Not transmitting.

SAMOS II (4100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 462 km, apogee 549 km, period 94.8.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

EXPLORER IX (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 502 km, apogee 2560 km, period 116.5.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Position uncertain.

EXPLORER XI (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 490 km, apogee 1776 km, period 107.9. Measures stellar gamma rays absorbed in Earth's atmosphere.

TRANSIT IVA (IVA, 175 lbs.; GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 893 km, apogee 985 km, period 103.8. GREB-INJUN—perigee 890 km, apogee 985 km, period 103.8. Not transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: Not transmitting. GREB III and INJUN failed to separate.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 748 km, apogee 814 km, period 100.3.

MIDAS III (3500 lbs.) U.S. Launched 7/12/61. Orbits Earth perigee 3399 km, apogee 3490 km, period 161.5.

EXPLORER XII (83 lbs.) U.S. Launched 8/16/61. Insufficient observations.

MIDAS IV (3500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3561 km, apogee 3691 km, period 166.0.

TRANSIT IVB (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee 948 km, apogee 1114 km, period 105.5. Damaged by radiation from U.S. July 9, 1962, nuclear test.

TRAAC (240 lbs.). U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee 958 km, apogee 1105 km, period 105.6. Damaged by radiation from U.S. July 9, 1962, nuclear test.

RANGER III (727 lbs.) U.S. Launched 1/26/62. Orbits Sun on 406.4 day cycle; lunar probe failed to impact, went into heliocentric orbit; aphelion 1.163 au, perihelion 0.9839 au. Not transmitting.

TIROS IV (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; apogee 695 km, perigee 858 km, period 100.3. Transmitting 136.23; 136.92 mc.

ORBITING SOLAR OBSERVATORY (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 547 km, apogee 593 km, period 95.9. Resumed transmitting on 136.744 mc. in latter part of June after stabilization lapse on May 22.

COSMOS II (wt. unknown) Russia. Launched 4/6/62. Orbits Earth; perigee 183 km, apogee 549 km, period 91.8 Transmission data not known.

ARIEL: INTERNATIONAL SATELLITE (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 383 km, apogee 1201 km, period 100.6. Damaged by radiation from U.S. July 9, 1962, nuclear test. Transmitting 136.406 mc.

TIROS V (285 lbs.) Launched 6/19/62. Orbits Earth; perigee 598 km, apogee 964 km, period 100.4. Transmitting 136.235; 136.922 mc.

TELSTAR I (170 lbs.) Launched 7/10/62. Orbits Earth; perigee 944 km, apogee 5641 km, period 157.7. Transmitting 136.233; 136.923 mc.

COSMOS VIII (wt. unknown) Launched 8/18/62. Orbits Earth; perigee 215 km, apogee 345 km, period 90.0.

MARINER II (447 lbs.) Launched 8/27/62. Heliocentric orbit on 348-day cycle. Planetary spacecraft came within 21,594 mi. of Venus Dec. 14. Perihelion 0.7046 au; aphelion 1.229 au.

TIROS VI (281 lbs.) Launched 9/18/62. Orbits Earth; perigee 677 km, apogee 720 km, period 98.7. Transmitting 136.233; 136.921 mc.

ALOUETTE (300 lbs.) Launched 9/29/62. Orbits Earth; perigee 997 km, apogee 1036 km, period 105.5. Satellite built by Canada; launched by U.S. Transmitting 136.978; 136.590; 136.080 mc.

EXPLORER XIV (89 lbs.) Launched 10/2/62. Orbits Earth; perigee 817 km, apogee 97,972 km, period 2184.6. Transmitting 136.44 mc.

RANGER V launched 10/18/62. Orbits Sun; perigee 0.9498 au, apogee 1.0681 au; period 370 days.

EXPLORER XV (98 lbs.) Launched 10/27/62. Orbits Earth; perigee 308 km, apogee 17,561 km, period 314 min. Transmitting 136.101 mc.

ANNA IB (350 lbs.) Launched 10/31/62. Orbits Earth; perigee 1063 km, apogee 1063 km, period 107.8. Transmitting 1620.324 mc.

MARS I (1965 lbs.) USSR. Launched 11/2/62. Was expected to come within 621-6831 miles of Mars on June 25, 1963, but has ceased transmitting.

INJUN 3 (40 lbs.) Launched 12/13/62. Orbits Earth; perigee 236 km, apogee 2678 km, period 115.1. Transmitting 136.868.

RELAY I (172 lbs.) Launched 12/13/62. Orbits Earth; perigee 1317 km, apogee 7444 km, period 185. Transmitting 136.140; 136.620 mc.

EXPLORER XVI (222 lbs.) Launched 12/16/62. Orbits Earth; perigee 759 km, apogee 1171 km, period 104.3. Transmitting 136.860; 136.200 mc.

TRANSIT 5A (135 lbs.) Launched 12/19/62. Orbits Earth; perigee 692 km, apogee 738 km, period 99.2.

SYNCOM (86 lbs.) U.S. Launched 2/14/63. Orbits Earth; perigee 34,185 km, apogee 37,014 km, period 1426.4. Not transmitting, communications lost when satellite went into orbit.

LUNIK IV (3135 lbs.) USSR. Launched 4/2/63. Position uncertain.

EXPLORER XVII (405 lbs.) U.S. Launched 4/3/63. Orbits Earth; perigee 263 km, apogee 879 km, period 96.1. Transmitting 136.316; 136.559 mc.

COSMOS XIV (wt. unknown) USSR. Launched 4/13/63. Orbits Earth; perigee 245 km, apogee 383 km, period 90.7.

COSMOS XVII (wt. unknown) USSR. Launched 4/22/63. Orbits Earth; perigee 216 km, apogee 753 km, period 94.7.

TELSTAR II (175 lbs.) U.S. Launched 5/7/63. Orbits Earth; perigee 970 km, apogee 10,802 km, period 225.2. Ceased transmitting 7/17/63.

LOFTI IIA and **SOLAR RADIATION SATELLITE** (58 lb. each) U.S. Launched together 6/15/63. Orbit Earth; LOFTI's perigee 183 km, apogee 723 km, period 93.7. Transmitting 136.380 mc. Solar Radiation Satellite's perigee 177 km, apogee 806 km, period 94.1. Transmitting 136.890 mc.

TIROS VII (297 lbs.) U.S. Launched 6/19/63. Orbits Earth; perigee 620 km, apogee 652 km, period 97.4. Transmitting 136.235, 136.922 mc.

RESEARCH SATELLITE FOR GEOPHYSICS (wt. unknown) U.S. Launched 6/28/63. Orbits Earth; perigee 410 km, apogee 1312 km, period 102.1. Not transmitting.

SECRET AF SATELLITES:

- Launched 4/9/62. Atlas-Agena B. Orbits Earth, perigee 2828 km, apogee 3367, period, 153.0.

- Launched 5/15/62. Thor-Agena B. Orbits Earth, perigee 274 km, apogee 460, period 92.0.

- Launched 6/18/62. Thor-Agena B. Orbits Earth, perigee 312 km, apogee 336 km, period 91.1

- Launched 8/23/62. Blue Scout. Orbits Earth, perigee 612 km, apogee 861 km, period 99.6.

- Launched 9/1/62. Atlas-Agena. Orbits Earth, perigee 298 km, apogee 572 km, period 93.3.

- Launched 10/26/62. Thor-Agena D. Orbits Earth, perigee 218 km, apogee 2097 km, period 142.5.

- Launched 12/13/62. Thor-Agena D. Orbits Earth, perigee 235 km, apogee 2588 km, period 114.1.

- Launched 1/16/63. Thor-Agena D. Orbits Earth, perigee 465 km, apogee 530 km, period 94.6.

- Launched 2/19/63. Blue Scout. Orbits Earth, perigee 498 km, apogee 802 km, period 97.8.

- Launched 5/9/63. Atlas-Agena B. Orbits Earth, perigee 3604 km, apogee 3687 km, period 166.5. Transmitting 136.892 mc.

- Launched 5/9/62. Atlas-Agena B (probably piggyback). Orbits Earth, perigee 3610 km, apogee 3687 km, period 166.5, transmitting 136.410 mc.

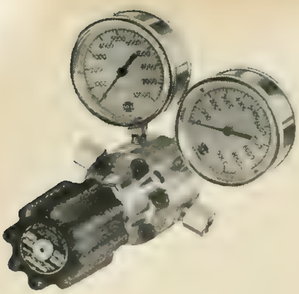
- Launched 6/12/63. (Booster unknown.) Orbits Earth, perigee 178 km, apogee 369 km, period 90.0.

- Launched 6/15/63. Blue Scout. Orbits Earth, perigee 177 km, apogee 806 km, period 94.5.

- Launched 6/16/63. (Booster unknown.) Orbits Earth, perigee 725 km, apogee 764 km, period 99.8.

- Launched 6/26/63. Thor-Agena. Orbital details unknown.

- Launched 6/28/63. Thor-Agena. Orbital details unknown.



GD700 SERIES GAS-O-DOME REGULATORS

- Models in bronze or stainless steel
- Pilot operated type
- Max. inlet: 3600 to 10,000
- Outlet range: 25-200 to 500-8000 psig
- Flows to 600 scfm
- Low Torque: 50 inch-lb. at 8000 psig
- Panel mounting
- Bulletin R43

LR SERIES LOADER REGULATORS

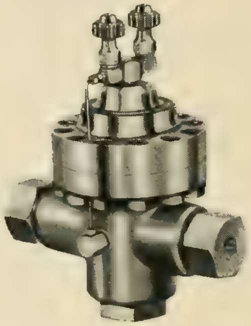
- Models in bronze, stainless steel, or aluminum
- Max. inlet: 7000 to 10,000 psig
- Outlet range: 25-200 to 500-10,000 psig
- Flow: 15 scfm
- Low Torque: 40 inch-lb. at 7,000 psig
  60 inch-lb. at 10,000 psig
- Panel mounting
- Bulletin R30

LV LOADER VALVE

- Models in bronze, stainless steel, or aluminum
- Inlet and outlet: 7000 psig
- Flow: 10 scfm
- Fast finger-tip control:
  30° clockwise, loads;
  30° counter-clockwise, bleeds
- Panel mounting
- Bulletin R31

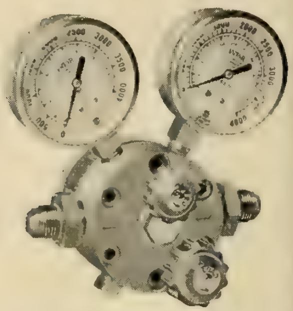
BPR SERIES BACK PRESSURE REGULATORS

- Models in bronze, stainless steel, or aluminum
- Adjustable relief ranges:
  From 25-500 psig
  to 2000-10,000 psig
- Bulletin R42



GD90B, GD100B, AND GD200A SERIES GAS-O-DOME REGULATORS

- Models in bronze or stainless steel
- Compensated, high-flow type
- Max. inlet and outlet: 6000 psig
- Flows to 80,000 scfm
- Remote control and/or
  panel mounting provisions
- Bulletins R33 to R40 incl.



GD61C AND GD80A SERIES GAS-O-DOME REGULATORS

- Models in bronze
- Inlet and outlet range:
  2500 to 10,000 psig
- Flows to 1500 scfm
- Remote control and/or
  panel mounting provisions
- Bulletins R46, R48, R53

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ASROC

Missiles
Surface-to-Surface

Asroc (RUR-5), Navy

TYPE: Antisubmarine rocket-boosted torpedo

STATUS: Operational on escort ships, destroyers & cruisers

PRIME CONTRACTOR: Minneapolis-Honeywell

FRAME CONTRACTOR: Minneapolis-Honeywell/General Mills

FRAME CONFIGURATION: Length, 15 ft.; torpedo-warhead length, 100 in.; diameter, 12 in.; span, 2.5 ft.; weight 1,000 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant

PROPULSION TYPE: Solid rocket

GUIDANCE CONTRACTOR: Sangamo Electric

GUIDANCE TYPE: Sonar detection in torpedo nose; type SQS-23; unguided during aerial flight

PAYLOAD: General Electric Mk 44 homing torpedo with nuclear warhead, or conventional depth charge

EQUIPMENT CONTRACTORS: Librascope-General Precision digital computer for fire control; Universal Match Co., launcher

PERFORMANCE: Range between 1,800 yds. & 8 n. mi.; speed about Mach 1

REMARKS: Initially operational in 1960; one "live" warhead fired during Pacific nuclear tests; advanced version under development

Alfa (RUR-4), Navy

TYPE: Antisubmarine rocket-boosted depth charge

STATUS: Operational

PRIME CONTRACTOR: Navy

FRAME CONTRACTOR: Avco

FRAME CONFIGURATION: Length, 8.5 ft.; diameter, 12.75 in.; weight, 500 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant

PROPULSION TYPE: Solid rocket

GUIDANCE CONTRACTOR: None

GUIDANCE TYPE: Free-flight

PAYLOAD: High-explosive depth charge

REMARKS: Operational aboard cruisers & destroyers since 1952; launched from turret-mounted guns to a maximum of 1,000 yds.

Astor, Navy

TYPE: Rocket-boosted antisubmarine torpedo

STATUS: Development

PRIME CONTRACTOR: Westinghouse

FRAME CONTRACTOR: Westinghouse

FRAME CONFIGURATION: Length, less booster, 20 ft.; weight, over 2,000 lbs.

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Wire-guided

PAYLOAD: Nuclear warhead on Mk 45 torpedo

PERFORMANCE: Range about 11 n. mi.

REMARKS: To be deployed aboard hunter-killer subs

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Atlas (PGM-16), Air Force

TYPE: Intercontinental ballistic missile

STATUS: Operational

PRIME CONTRACTOR: STL, systems engineering & technical direction

FRAME CONTRACTOR: General Dynamics/Astronautics

FRAME TYPE & CONFIGURATION: Stainless-steel pressurized tankage; length, 82.5 ft.; tankage diameter, 10 ft.; base diameter, 16 ft.; launch weight, 266,000 lbs.

PROPULSION CONTRACTOR: Rocketdyne

PROPULSION TYPE: Two liquid-propellant booster engines & one sustainer; boosters produce 165,000 lbs. thrust each and sustainer produces 60,000 lbs.; uses LOX & RP-1 propellants

GUIDANCE CONTRACTOR: GE/Burroughs for Series D; American Bosch Arma for Series E and F

GUIDANCE TYPE: Radio-inertial for Series D (first four squadrons) and all-inertial for remaining nine squadrons

PAYLOAD: Nuclear warhead; re-entry vehicles by GE and Avco

GROUND EQUIPMENT CONTRACTORS: General Dynamics, launch facilities integration; propellant loading system, Arthur D. Little Co.; propellant utilization system, Acoustica Associates

PERFORMANCE: Range, 1,800-9,000 miles; speed, over 16,000 mph

REMARKS: 13 squadrons operational at 11 bases with total of 129 missiles; phase-out to begin soon; modification to space launch vehicle continuing

Corporal (MGM-5), Army

TYPE: Single-stage tactical, ballistic

STATUS: Operational

PRIME CONTRACTOR: Firestone Tire and Rubber Co.

FRAME CONFIGURATION: Length, 45 ft.; diameter, 30 in.; weight 11,000 lbs.; material, steel

PROPULSION CONTRACTOR: Ryan

PROPULSION TYPE: Liquid, nitric acid & aniline

GUIDANCE CONTRACTOR: Gilfillan Bros.

GUIDANCE TYPE: Preset & command

PAYLOAD: Nuclear or conventional

PERFORMANCE: Range, 75 n. mi.; speed, supersonic

REMARKS: Now being replaced by Sergeant

Davy Crockett Army

TYPE: Tactical nuclear support weapon

STATUS: Operational

PRIME CONTRACTOR: Army Weapons Command in-house

FRAME TYPE & CONFIGURATION: Bulbous, 279-mm super caliber projectile fired from either 120-mm or 155-mm recoilless rifle through adapter pistons

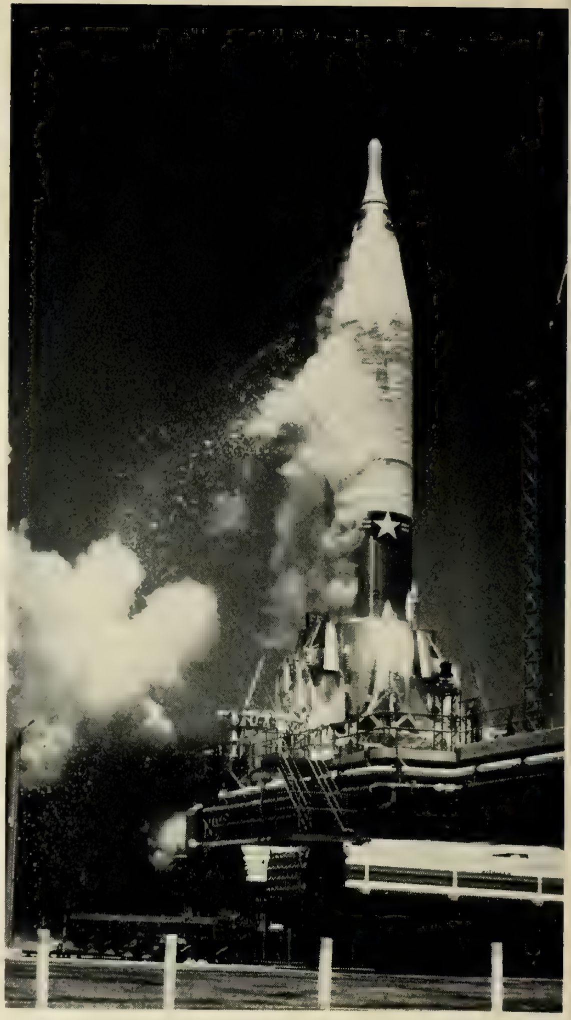
PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Sub-kiloton nuclear warhead

PERFORMANCE: Classified

REMARKS: Deployed in Europe; $13 million provided in FY '64 budget; 20 weapons per division; defensive weapon to prevent rapid overrun of Europe


ATLAS

CORPORAL

NOT ALL RUST IS RED

By the laws of nature, *all* materials deteriorate in some manner—and the common deterioration process for metals exposed to air and water is called "oxidation."

The product of this oxidation may be any of several colors, depending on the metal itself. The color will usually be blue-green for copper, black for lead, white or gray for aluminum and zinc, or red-brown for most types of steel. The oxidation process and the resulting corrosion products on all of these metals are similar except in color, but the persistent image when the word "rust" is used is the red-brown oxidation of steel.

Neither the presence of rust on any metal nor its color is an exact indication of the metal's corrosion resistance. USS COR-TEN Steel, for example, has 4 to 6 times the corrosion resistance of structural carbon steel, because it quickly forms a tightly adherent dark brown rust that is a *barrier* against further corrosion. In fact, designers frequently *want* rust for aesthetic reasons: the blue-green oxide patina of century-old copper roofs is one example, and some designers leave USS COR-TEN Steel unpainted to develop the rich brown rust color.

However, rust itself is normally considered undesirable and has become associated in the minds of many people with rapid corrosion of the metal which will eventually lead to failure. To take commercial advantage of this obvious fact, some manufacturers of materials that compete with steel persistently claim that their materials do not rust. The kindest thing that can be said about such a statement is that it is misleading. To prove this point for yourself, you may enjoy taking a little test that has delighted many engineers as well as laymen.

Here's the background:

The United States Atomic Energy Commission conducted an exhaustive series of corrosion tests to guide them in the selection of materials for use in water-cooled nuclear reactors. Samples of over 100 materials were suspended in pure, still water in a 500°F. autoclave for three to six months. The specimens were then rated for their corrosion resistance, Class I having the best corrosion resistance, Class III having the poorest corrosion resistance. Now, take a pencil and classify the following materials as you think they made out in the tests.*

Material	Class I High Resistance	Class II Medium Resistance	Class III Low Resistance
1. Quartz			
2. Tungsten Carbide			
3. Platinum			
4. Vanadium			
5. Monel			
6. Silver			
7. Stainless Steel (Type 410)			
8. Aluminum			
9. Titanium			
10. Beryllium			
11. Fluorocarbon Plastic			
12. Copper			
13. Polyethylene			
14. Brass			
15. Nickel			
16. Lead			
17. Magnesium			
18. Stainless Steel (Type 302)			
19. Zinc			
20. Cadmium			

Here are the answers: 3, 9, and 18 were in Class I. 5, 7, 11, and 15 were in Class II. *All the rest* were in Class III.

Incidentally, if carbon steel had been included in the test, it would have ended up in Class III also.

Are the above results misleading? No —*because the exact conditions of the test are defined. They would be seriously misleading if they were suggested as an accurate classification of corrosion resistance under any other conditions.* As test conditions change, corrosion rates would also be expected to change.

There are several excellent reference works that outline the corrosion resistance of various materials. A standard work is, "The Corrosion Handbook" published by John Wiley & Sons. There are many other reference books on this subject, which contain a monumental amount of data on the corrosion of design materials. Even so, the surface has barely been scratched, for there are literally millions of possible combinations when you take into account all the design materials and all the chemical or atmospheric environments in which they might exhibit some corrosion.

But one thing is certain: you cannot justify the use of a material on the basis of its relative corrosion resistance alone. For example, there are many steels and other materials that have greater corrosion resistance than carbon steel, yet carbon steel is still the most widely used metal in the world. It has been the basic design material for just about every large ship, bridge, building, and tower ever built. Carbon steel is used because it has the strength and stiffness for the job; and, even when it must be protected by paint or other coatings, it is still the biggest bargain in any industry.

Certainly the word "rust" has, through casual usage, become associated with the oxidation of steel. Even experienced engineers and designers often use this word "rust" loosely, but they are not misled as to its *meaning*. The "rusting" of metals is an important consideration in their design work, whether that "rust" be red, white, gray, green, or black. But, no matter how loosely they may use the word, they recognize as professional men that not all "rust" is red.

• • •

*From *Corrosion and Wear Handbook for Water-Cooled Reactors*, United States Atomic Energy Commission, Division of Reactor Development, Naval Reactors Branch.

Test Conditions. The classification of materials was based on corrosion tests conducted in high-pressure autoclaves containing high-purity water at 500°F. No circulation of the water was provided for, other than movement resulting from thermal circulation. In general, the water contained 10 to 30 cc. of oxygen (STP) per kilogram of water, and the initial electrical resistivity was 500,000 ohm-cm or greater. The tests lasted from 3 to 6 months.

Definition of Classifications—*Class I:* Materials showing the highest resistance to corrosion. These may be used with the least amount of consideration for the particular application. Weight changes in this group were generally on the order of $+10 \text{mg/dm}^2/\text{mo}$ (weight gain attributed to adherent scale). *Class II:* Materials were appreciably less corrosion resistant than those listed in Class I. They require some consideration in their application in order to insure satisfactory performance. Weight changes in this group were generally on the order of $+50 \text{ mg/dm}^2/\text{mo}$. Many of the materials are subject to minor pitting, especially in crevices. *Class III:* Materials in this group usually show weight changes on the order of several hundred $\text{mg/dm}^2/\text{mo}$ and/or are susceptible to severe localized attack.

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"Here's why you should come to U. S. Steel with your corrosion problems"

—Herb Phelps, Division Chief, Corrosion Technology Division, Applied Research Laboratory, U. S. Steel Corporation

Dr. Herb (E. H.) Phelps got his BChe from Clarkson College of Technology, and his MS and PhD from Case Institute of Technology. He joined USS in 1955 after three years in corrosion work at Wright Air Development Center. He is a member of the National Association of Corrosion Engineers and the Electrochemical Society.

"Corrosion losses in the United States amount to about $7 billion every year, and here in our Applied Research Laboratory at Monroeville, Pa., we're doing something about it," says Herb Phelps. "In fact, we're doing substantially more than anyone else in the industry, which seems to me a good reason to come to U. S. Steel when you're looking for steels to solve corrosion problems.

"The story of our corrosion program goes all the way back to March 1, 1929. That was before my time, but the steel that resulted from the first program—USS Cor-Ten High-Strength Low-Alloy Steel—is still more in demand than any other high-strength, corrosion-resistant steel on the market. When Cor-Ten Steel was introduced, our tests enabled us to show that it had 4 to 6 times more resistance to atmospheric corrosion than carbon steel had. This ratio has been fully substantiated by later testing programs that have also developed atmospheric corrosion data for hundreds of other experimental compositions. Experience has shown that in many applications there is a definite relationship between these corrosion test data and service performance.

"Over the years since 1929, we have exposed over 64,000 samples of steel in corrosion tests, some of them for as long as 30 years.

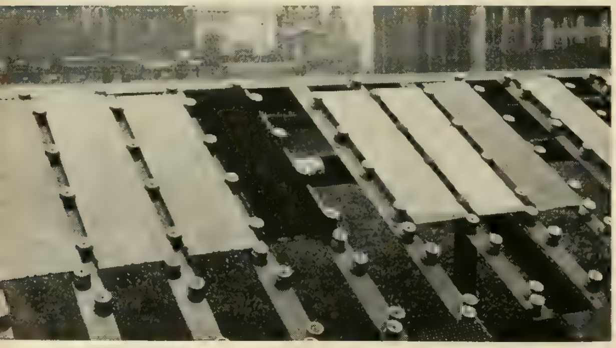
"Today, we literally have acres of test racks around the country, exposing samples of every steel used in metalworking to rural, industrial, and coastal atmospheres. We also have test samples on the roofs of buildings in several major cities in the United States. We have hundreds of samples built into structures, inserted in pipelines and vessels used by dozens of processing industries, and during the winter months we even expose samples underneath the front bumpers of about 70 automobiles to determine the effects of road salts. Every sample is measured or examined for corrosion loss, some of them several different times.

"But that's only part of the story. Here at the Applied Research Laboratory, we have a full-time crew of 28 technicians who complete over 100 test programs every year on applications for steel products. We probe the corrosive effects of a great many materials . . . from soft drink syrup to liquid fertilizers. We're trying to find out the cause of stress corrosion, for example, and how proper design and special treatments can prevent it. We investigate things as mundane as the corrosion of stainless steels by dairy cleaning compounds, and as exotic as corrosion-erosion of sensitized stainless in a thorium dioxide-uranium trioxide slurry, which is the rather high-sounding name for a certain type of fuel and coolant for a nuclear-reactor power plant.

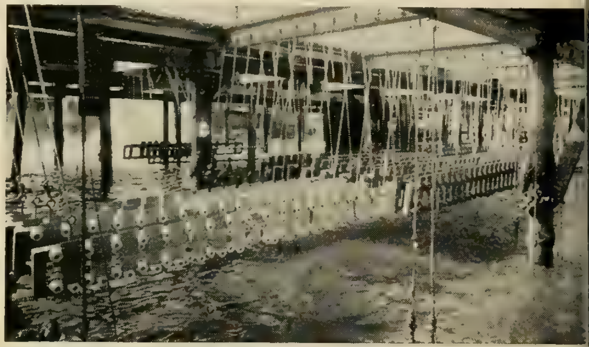
"I think you'll agree that if you have a corrosion problem, we're the people to talk to. Many of our test installations include samples related to customer service, and we often investigate customer corrosion problems in the field. We have cooperative corrosion testing programs going on at all times involving anything from the development of longer lasting auto mufflers to the development of steels that are destined for service outside the earth's atmosphere.

"That's about it. Our corrosion program is just one more reason why you get **more** than steel when you buy from United States Steel."

One thing Dr. Phelps didn't mention. In addition to the industry's finest metallurgical and technical service, we deliver the finest products you can buy. If you need corrosion-resistant steels—and we have a full-sized family of them, from USS Cor-Ten High-Strength Low-Alloy Steel to the entire array of stainless steels—call U. S. Steel. USS and Cor-Ten are registered trademarks.



Samples of USS Steels for architectural use are exposed on the roofs of buildings in several major cities across the country. This rack is atop a building on lower Broadway, New York City.



Corrosion-test installation at Harbor Island, North Carolina. The importance of sea-water testing is emphasized by U. S. Navy statistics that point out that every $1 spent to prevent corrosion on ships ultimately saves $90.

Various grades and finishes of stainless steel for auto trim are tested in this dip-and-dry apparatus. The test solution simulates the effect of road salts. Eight hours of this testing gives USS researchers an idea of the relative corrosion resistance of various steels during the normal life of a car.

Research into the mechanisms of corrosion is an important part of United States Steel's corrosion program. This device, a potentiostat, measures the current required to maintain a constant potential in the electrochemical processes of corrosion.

Atmospheric stress-corrosion tests of bent-beam alloy and stainless steel specimens offer a guide to specification of steels for aircraft and missile uses. The microstructural characteristics of stress corrosion are investigated in several USS research projects.

United States Steel USS

ENTAC

ENTAC (MGM-32), Army

TYPE: Antitank missile

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

FRAME CONFIGURATION: Weight, 37 lbs. with launcher, 27 lbs. without launcher

PROPULSION TYPE: Solid

GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explosive shaped charge

PERFORMANCE: 6,600-ft. range; speed about 180 mph

REMARKS: Being bought in large quantities by U.S. Army to replace SS-10

Honest John (MGR-1), Army

TYPE: Artillery rocket

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft

FRAME CONTRACTOR: Douglas Aircraft/Emerson Electric

FRAME TYPE & CONFIGURATION: Major material, steel; advanced version material, aluminum; length, 24.8 ft.; diameter, 30 in.; weight, 4,500 lbs.

PROPULSION CONTRACTOR: Hercules Powder Co., main; Thiokol Chemical Corp., spin rockets

PROPULSION TYPE: Single-stage solid propellant

GUIDANCE TYPE: Free-flight, spin-stabilized

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range, 12 mi.; speed, Mach 1.7

REMARKS: To be replaced by Lance; advanced version developed; being used by NATO

Lacrosse (MGM-18), Army

TYPE: Tactical support against hard-point targets

STATUS: Operational

PRIME CONTRACTOR: Martin/Orlando

FRAME TYPE & CONFIGURATION: Length, 19 ft.; wingspan, 108 in.; diameter, 20.5 in.; weight, 2,300 lbs.; has swept-back cruciform wings

PROPULSION CONTRACTOR: Thiokol

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Federal Div., ITT

GUIDANCE TYPE: Command

PAYLOAD: Nuclear or high-explosive warhead

GROUND EQUIPMENT: Fired from standard Army truck

PERFORMANCE: Range less than 20 miles; speed, transonic

REMARKS: To be replaced by Lance; three units operational in Europe, eight activated

HONEST JOHN

TOWERS OF STRENGTH Structure: Large Solid Motor Static Test Stand, Edwards Air Force Base, California. Mission: measure the performance of large solid motors delivering up to 1.5 million pounds thrust with Thrust Vector Control. Ultimate capability: testing mammoth motors delivering 4 million pounds thrust. Overall complex—including buildings, shops, thrust vector control assembly and test facilities—designed by AETRON under the direction of the Air Force Space Systems Division.

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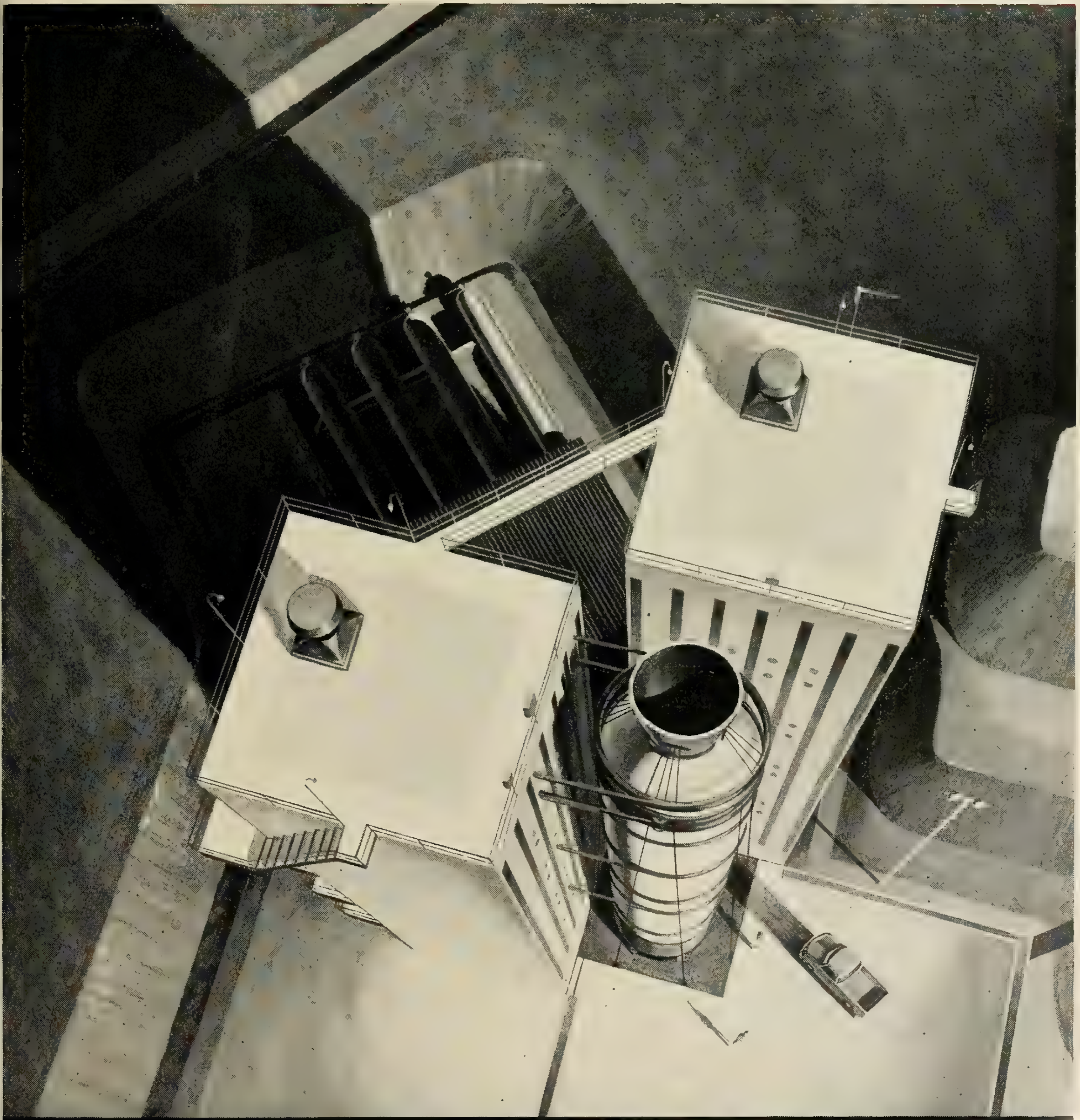


ARCHITECTURE • ENGINEERING • INSTRUMENTATION • FABRICATION • CONSTRUCTION MANAGEMENT

M-72 ROCKET GRENADE

Lance (MGM-52), Army

TYPE: Division support missile

STATUS: Initial development

PRIME CONTRACTOR: Chance Vought Corp. div. of Ling-Temco-Vought

PROPULSION TYPE: Prepackaged storable liquid rocket

GUIDANCE CONTRACTOR: Systron-Donner

GUIDANCE TYPE: Simplified inertial (Automet)

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range between 3 and 30 miles; very lightweight system with great mobility

REMARKS: Will replace Lacrosse and Honest John

Little John (MGR-3), Army

TYPE: Support of airborne operations

STATUS: Operational

PRIME CONTRACTOR: Emerson Electric Co./Consolidated Western Steel

FRAME TYPE & CONFIGURATION: Steel & aluminum; length, 14.5 ft.; diameter, 12.4 in.; weight, 800 lbs.

PROPULSION CONTRACTOR: Hercules Powder Co.

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range, over 10 miles; speed, supersonic

REMARKS: Supplements medium and heavy artillery in airborne divisions and air-transportable commands; two battalions activated in 1961; may be replaced by Lance

M72 Rocket Grenade, Army

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Hesse-Eastern Div., Flightex Fabrics, Inc.

FRAME TYPE & CONFIGURATION: Length, 25 in.; diameter, 3 in.; weight, 4.5 lbs.

PROPULSION TYPE: Solid propellant, which burns out before rocket leaves launch tube

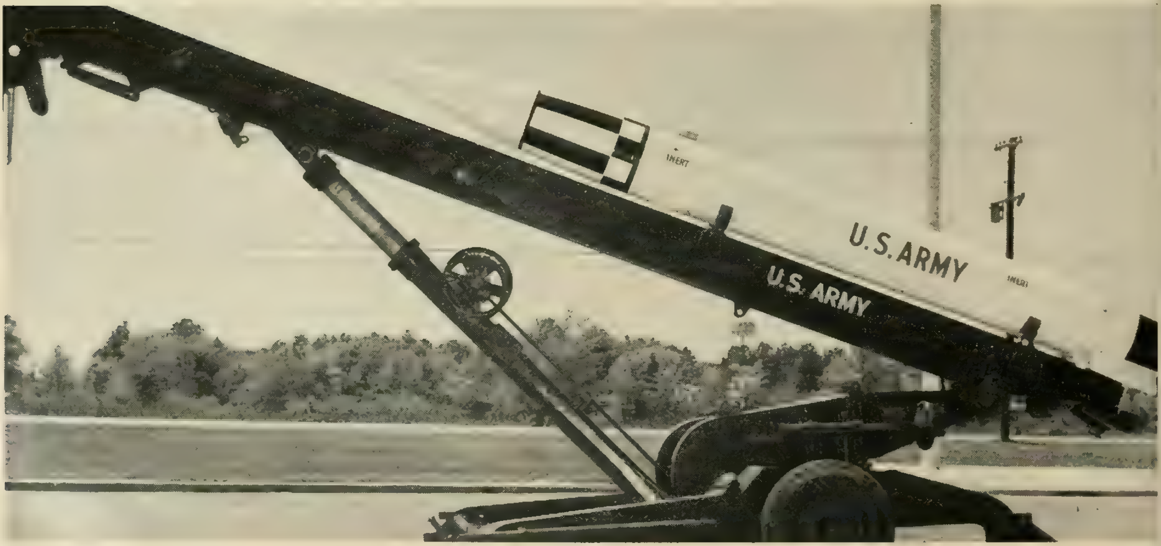
GUIDANCE TYPE: Free-flight, fin-stablized

PAYLOAD: "Octol" high-explosive warhead

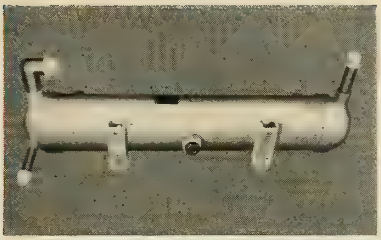
PERFORMANCE: Range 10-500 yds.

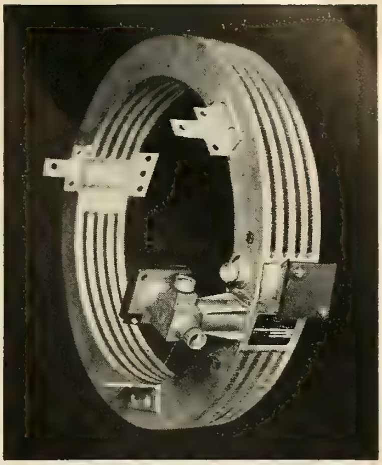
REMARKS: Carrying tube serves as disposable launcher; will replace rifle grenades and 3.5-in. rocket launcher; formerly called LAW (light antitank weapon); useful against tanks, pillboxes and other hard-point targets

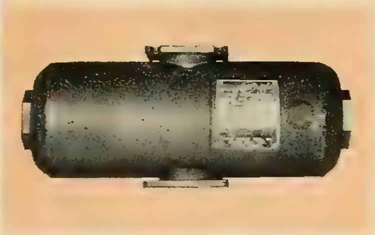
LITTLE JOHN

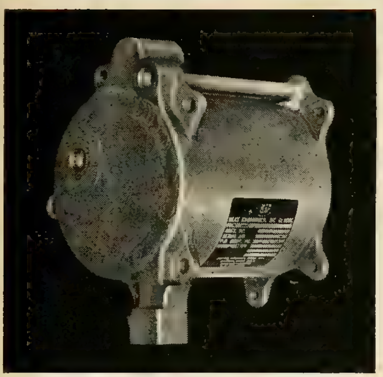


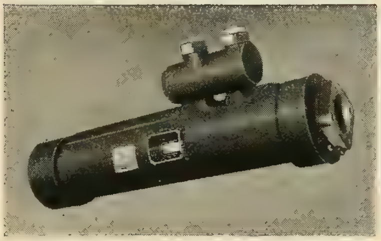
IRBM Guidance Cooler, FC-75/Air

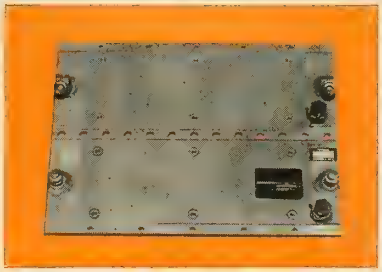

Missile GSE, Freon/FC-75 Evaporator


Space Liquid Engine, LH_2 Heat Exchanger


Missile Fuel/Hydraulic Oil Cooler


Manned Spacecraft, APU Lube Cooler


ICBM RP-1/Hydraulic Oil Cooler


ICBM Guidance System Cold Plate

Missile Guidance Cooler, FC-75/Air

Missile Engine Lube Oil Cooler

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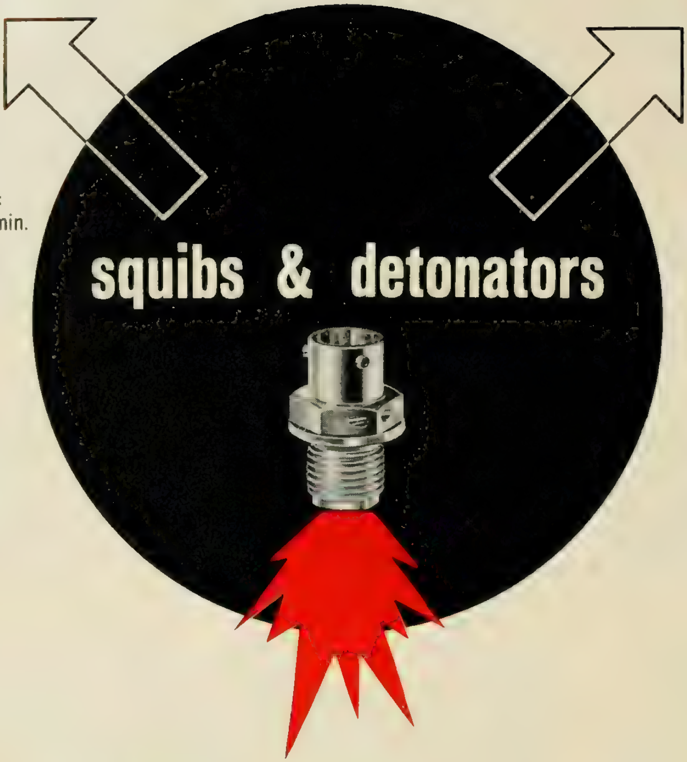

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Mace (MGM-13), Air Force

TYPE: Air-breathing

STATUS: Operational

PRIME CONTRACTOR: Martin Co.

FRAME TYPE & CONFIGURATION: Pilotless aircraft type; length, 44 ft.; wingspan, 22.5 ft.; height, 9.5 ft.; weight, 18,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Allison

PROPULSION TYPE: Solid booster rocket/J-33 turbojet

GUIDANCE CONTRACTOR: Goodyear/AC Spark Plug

GUIDANCE TYPE: ATRAN, automatic terrain radar and navigator/all-inertial

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range: model A, over 500 n. mi.; model B, over 1,200 n. mi.; speed, over 650 mph; ceiling, over 40,000 ft.

REMARKS: A substantially improved version of Matador, which it replaced; deployed in Europe and Okinawa

Matador (MGM-1C), Air Force

TYPE: Air-breathing

STATUS: Operational, being phased out of U.S. forces into Allies' control

PRIME CONTRACTOR: Martin Co.

FRAME TYPE & CONFIGURATION: Pilotless aircraft type; length, 39.6 ft.; height, 9.67 ft.; wingspan, 27.8 ft.; weight, 10,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Allison

PROPULSION TYPE: Solid rocket booster/J-33 turbojet

GUIDANCE CONTRACTOR: Air Force

GUIDANCE TYPE: Dual system including MSQ radar line-of-sight control and "Shanicle," a form of LORAN, using hyperbolic grid system

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range, over 600 n. mi.; speed, over 650 mph.; ceiling, over 35,000 ft.

REMARKS: Being turned over to West Germany and Nationalist Chinese; deployed on Taiwan and in Korea

Minuteman (LGM-30), Air Force

TYPE: Intercontinental ballistic missile

STATUS: Operational

SYSTEMS CONTRACTOR: STL, systems engineering and technical direction

MAJOR CONTRACTOR: Boeing Co., major contractor and systems integrator; Avco, re-entry vehicle

FRAME TYPE & CONFIGURATION: Three-stage; length, 53.7 ft.; diameter at interstage junction, 6.2 ft.; weight, over 65,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Aerojet/Hercules, respectively by stages

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Autonetics Div., North American Aviation

GUIDANCE TYPE: All-inertial

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, 5,500 n. mi.; speed, over 15,000 mph; apogee, 700 miles; reaction time, 32 sec.; target selection time, less than 10 sec.; yield, about one megaton

REMARKS: Eventual force size may be 1,300-1,700; advanced version under development; to be deployed at Malmstrom AFB, Mont., Ellsworth, S.D., Whiteman, Mo., Minot, N.D., and Grand Forks, N.D.; launched from underground silos

MACE

MINUTEMAN

MMRBM, Air Force

TYPE: Mobile Medium-range Ballistic Missile

STATUS: Development; program definition phase

PRIME CONTRACTOR: Hughes, Northrop, integration, assembly & checkout; Aeronutronic/Fairchild Stratos/Sperry Rand, reentry system; Hughes/Martin, Sylvania, command & control

FRAME TYPE & CONFIGURATION: Not available, but system must be contained in one mobile vehicle

PROPULSION CONTRACTOR: Thiokol

PROPULSION TYPE: Two-stage solid propellant

GUIDANCE CONTRACTOR: General Precision

GUIDANCE TYPE: Stellar inertial

PAYLOAD: Nuclear or high-explosive warhead

GROUND EQUIPMENT CONTRACTORS: Goodyear Aircraft, transporter-erector-launcher

PERFORMANCE: Range, 300-1,500 n. mi.; extremely mobile; short reaction time

REMARKS: Designed to fill the range gap between Pershing & Thor-Jupiter-class missiles; mobility must be compatible with road nets of Europe & Asia; command-control problems considered greater than usual

Pershing (MGM-31), Army

TYPE: Two-stage ballistic missile

STATUS: Nearly operational

PRIME CONTRACTOR: Martin Orlando

FRAME CONFIGURATION: Length, 35 ft.; diameter, 40 in.; weight, 10,000 lbs.

PROPULSION CONRACTOR: Thiokol

PROPULSION TYPE: Two-stage solid-propellant

GUIDANCE CONTRACTOR: Eclipse-Pioneer Div., Bendix

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., XM-474 tracked vehicles; Universal Match Corp., transporter/erector/launcher; Collins Radio, communications

PERFORMANCE: Range, 100-400 n. mi.; speed, supersonic

REMARKS: Flight-test program, including shots from Utah to New Mexico, nearly complete; first tactical equipment delivered to troops in December, 1962; Germany buying

PERSHING

Hydraulic power package lifts the giant Saturn gantry complex before blastoff

October 27, 1961 (10:06 A.M. EST) at Cape Canaveral's Complex 34 marked the successful launching of the first NASA Saturn (C-1) space vehicle. A Denison hydraulic power system played a key role in the ground support phase of the Saturn launching. The unit (two were designed and built by Denison in the near-record short period specified by NASA) pulls the locking pins and raises the huge gantry tower complex onto trucks prior to firing.

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120 Inch Diameter Rocket Motor Casing Ring Produced From 50,000 Pound Ingot

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Now, new possibilities for the use of these ultra-clean steels are opened up with the new Midvac furnace designed to produce ingots up to 60 inches in diameter and weighing 110,000 pounds. This permits the design of larger rocket motor components, forgings for nuclear reactor parts, turbine shafts and other large commercial parts. For complete details on these new possibilities, get your copy of the Midvac Steel data book . . . write to

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POLARIS A3

Redstone (PGM-11), Army

TYPE: Single-stage ballistic missile

STATUS: Operational

PRIME CONTRACTOR: Chrysler Corp.

FRAME TYPE & CONFIGURATION: Length, 69 ft.; diameter, 70 in.; weight, 62,000 lbs.

PROPULSION CONTRACTOR: Rocketdyne

PROPULSION TYPE: Liquid

GUIDANCE CONTRACTOR: Sperry Farragut

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range, 200 miles; speed, supersonic

REMARKS: Being replaced by Pershing; placed first U.S. satellite in orbit as first stage of Jupiter-C composite vehicle; man-rated version was used by NASA to boost Shepard and Grissom on suborbital flights

Polaris (UGM-27), Navy

TYPE: Two-stage ballistic missile fired from submerged submarines

STATUS: Operational in two of its three versions

PRIME CONTRACTOR: Lockheed

FRAME TYPE & CONFIGURATION: A-1 length, 28 ft.; diameter, 4.5 ft.; weight, 28,000 lbs. A-2 & A-3 length, 30.5 ft.; weight, 30,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General/Hercules Powder

PROPULSION TYPE: Solid propellants

GUIDANCE CONTRACTOR: GE/MIT/Hughes

GUIDANCE TYPE: All-inertial

PAYLOAD: Nuclear warhead; about one megaton

EQUIPMENT CONTRACTORS: Nortronics, checkout; Westinghouse, launch equipment; Vitro, systems engineering coordination & training; Systron-Donner, ignition programming

PERFORMANCE: Range A-1, 1,200 n. mi.; A-2, 1,500 n. mi.; A-3, 2,500 n. mi.; speed about 8,000 mph

REMARKS: Nine submarines each with 16 missiles operational with A-1 and A-2; Deployment of A-3 expected this year, with all subs using it eventually; total authorized fleet ballistic missile submarine program is 41 ships; subs now deployed in Atlantic and Mediterranean, with Pacific servicing facilities under construction; British to buy missiles from U.S. for Royal Navy

Regulus (RGM-6), Navy

TYPE: Air-breathing missile

STATUS: Operational

PRIME CONTRACTOR: Ling-Temco-Vought

FRAME TYPE & CONFIGURATION: Length, 34 ft.; wingspan, 21 ft.; diameter, 4.5 ft.; weight 14,000 lbs.

PROPULSION CONTRACTOR: Aerojet/Allison

PROPULSION TYPE: Solid rocket booster/J-33 turbojet

GUIDANCE CONTRACTOR: Sperry

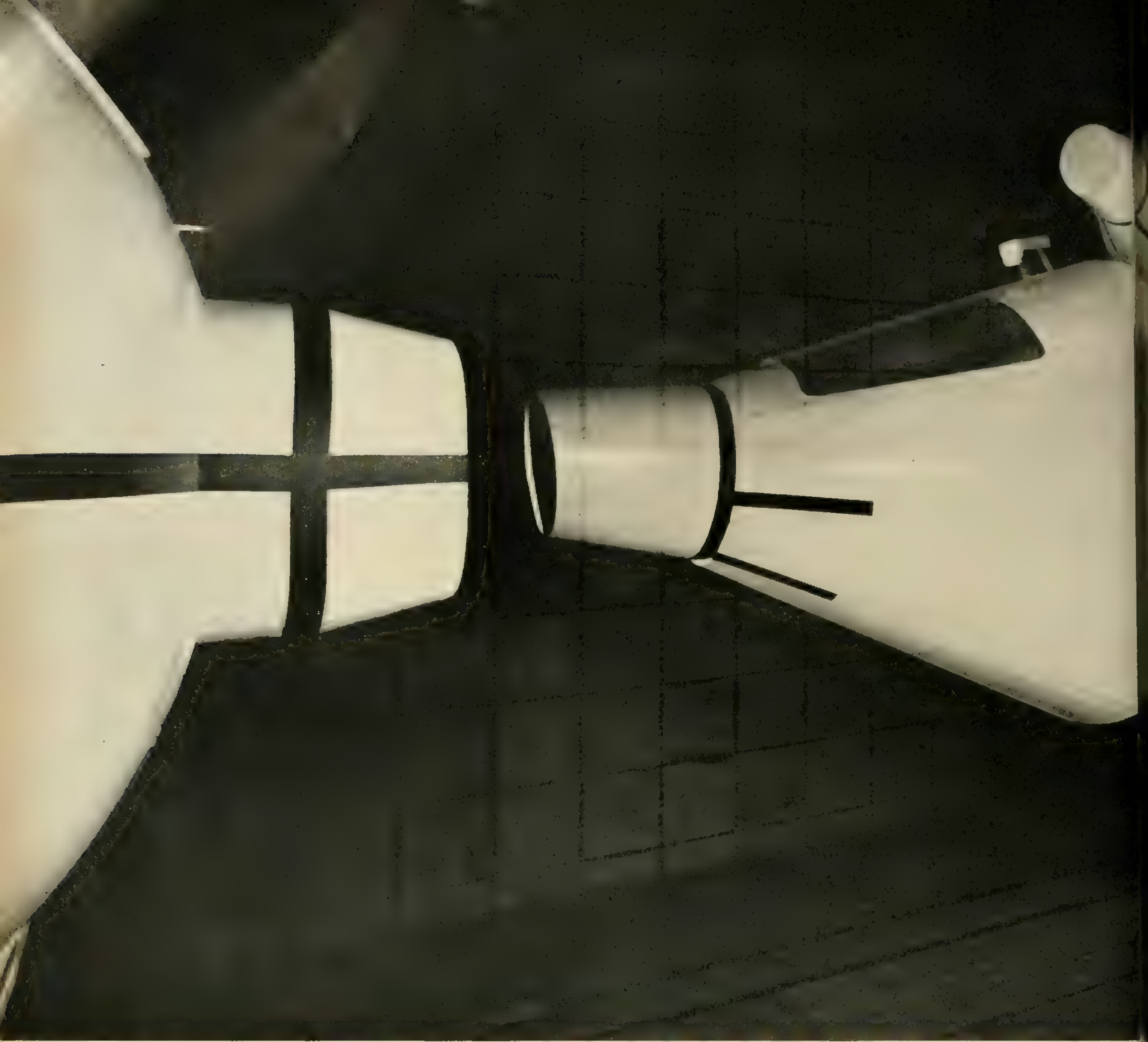
GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear warhead

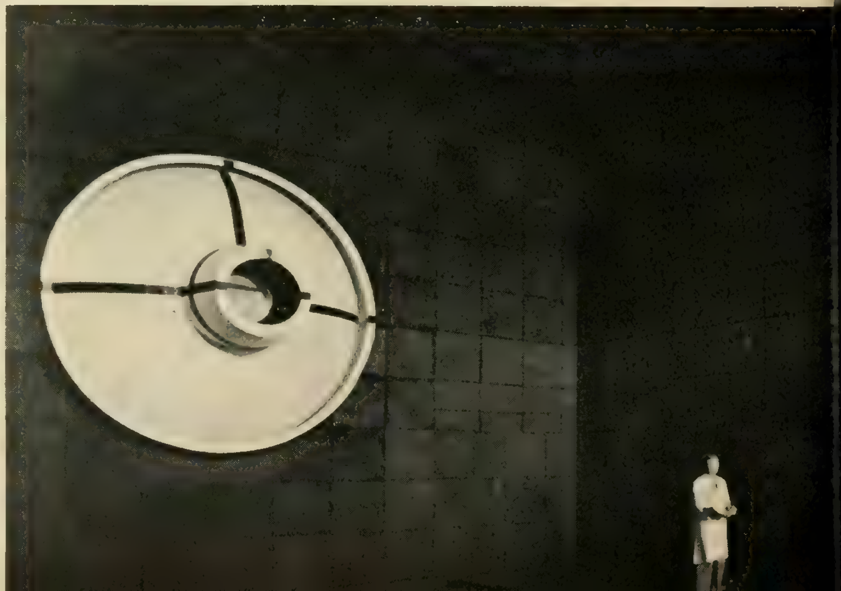
EQUIPMENT CONTRACTORS: Fruehauf, launcher & transport vehicles

PERFORMANCE: Range, 500 n. mi.; speed, 600 mph; ceiling, over 40,000 ft.

REMARKS: Expected to be phased out soon as more modern systems appear; currently deployed aboard five submarines and two cruisers



Triple exposure photograph in new Martin Rendezvous Laboratory shows spacecraft making approach



New 100-foot-long laboratory simulates complete closing and docking for both manned and unmanned missions. Visual and television surveillance can be used during manual operation, radar and laser sensors in fully automatic exercises.

A bank of analog computers supplies effects of space to the mobile module. All room walls are anechoic to free sensors of interfering noise.

MARTIN MARTIN MARIETTA

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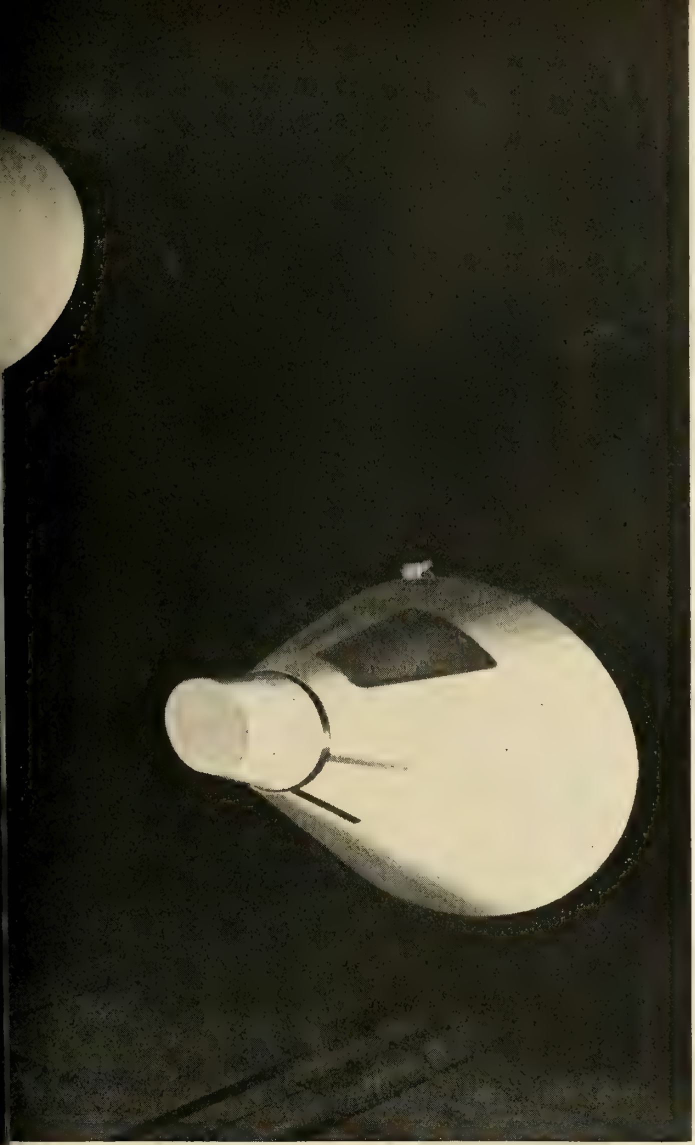
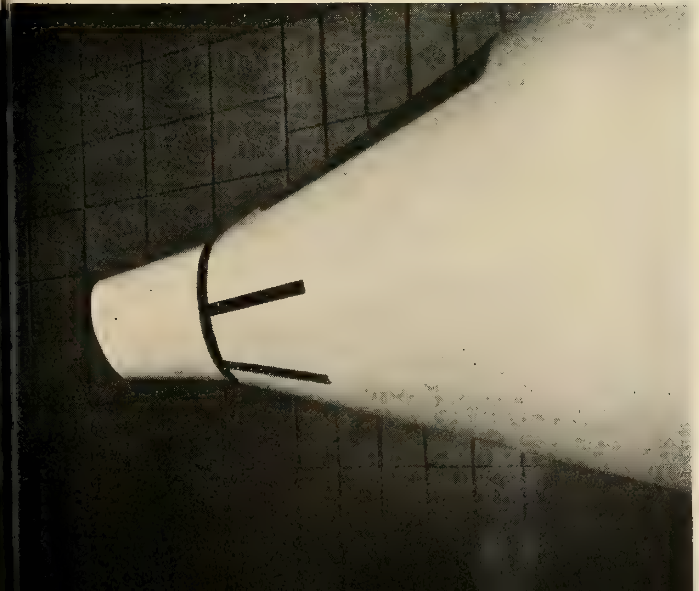


and closure for docking under simulated space conditions.



MANNED RENDEZVOUS:

New Rendezvous Laboratory at Martin investigates closure and docking techniques

Rendezvous of orbiting spacecraft is an indispensable technique in future space planning. It is a science of precision without precedent, dependent largely on booster accuracy and extremely sophisticated closing and docking techniques.

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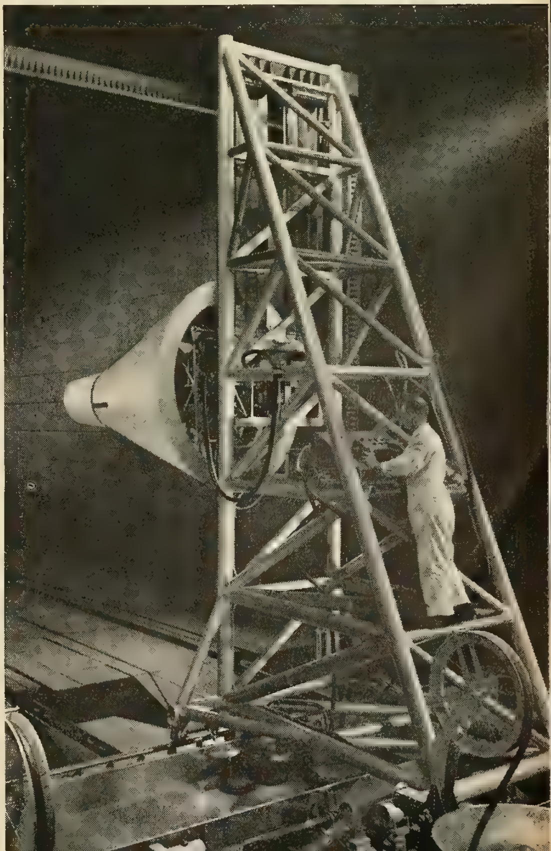
This Martin facility will speed the nation's development of rendezvous techniques for manned space systems. At Martin, systems management means the best possible product, in the shortest possible time, at the lowest possible cost.



Sergeant (MGM-29), Army

TYPE: Single-stage ballistic missile

STATUS: Operational

PRIME CONTRACTOR: Sperry Utah Co.

FRAME CONFIGURATION: Length, 34.5 ft.; diameter, 31 in.; weight, 10,000 lbs.

PROPULSION CONTRACTOR: Thiokol

PROPULSION TYPE: Single-stage solid-propellant, employs drag brakes in terminal phase

GUIDANCE CONTRACTOR: Sperry

GUIDANCE TYPE: Inertial

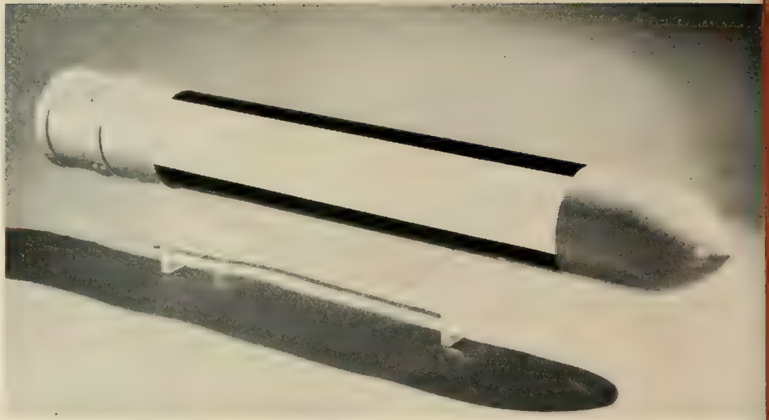
PAYLOAD: Nuclear or high-explosive warhead

GROUND EQUIPMENT CONTRACTORS: Fruehauf, transport vehicles; AMF, erector/launcher; AiResearch, gas turbine generators

PERFORMANCE: Range 25-75 n. mi.; speed, supersonic

REMARKS: Major procurement completed in FY '63; replacing Corporal; Germany buying

SERGEANT



SHILLELAGH

Shillelagh (MGM-51), Army

TYPE: Tactical guided missile for infantry support

STATUS: Development

PRIME CONTRACTOR: Philco Aeronutronic

FRAME CONFIGURATION: Diameter, 152 mm; other figures unavailable

PROPULSION CONTRACTOR: Picatinny Arsenal Amoco Chemicals Corp.; Norris Thermador, motor cases

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Aeronutronic

GUIDANCE TYPE: Command

PAYLOAD: Nuclear or high-explosive warhead

GROUND EQUIPMENT CONTRACTORS: Cadillac Motor Div., General Motors Corp., supplies the General Sheridan armored vehicle armed with Shillelagh

PERFORMANCE: Classified

REMARKS: To be used against tanks, pillboxes and other hardpoint targets; being tested at White Sands Missile Range; will use multi-system test equipment

SLAM, Air Force

TYPE: Supersonic low-altitude intercontinental missile

STATUS: Powerplant and component development

PRIME CONTRACTOR: Ling-Temco-Vought

PROPULSION CONTRACTOR: Atomics International/Lawrence Radiation Laboratory, reactor; Marquardt, overall propulsion

PROPULSION TYPE: Nuclear-powered, air-breathing ramjet developed under the Pluto program; feasibility proven by Tory reactor tests

GUIDANCE TYPE: Probably all-inertial, with terrain-avoidance radar feature

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, unlimited; speed, over Mach 3

REMARKS: Being developed to perform long-duration and long-distance aerial patrols similar to Polaris submarine concept

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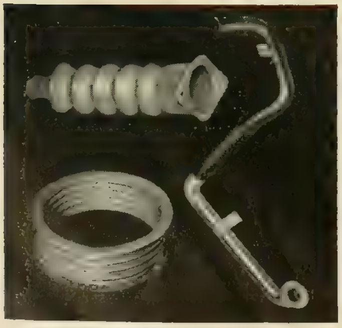

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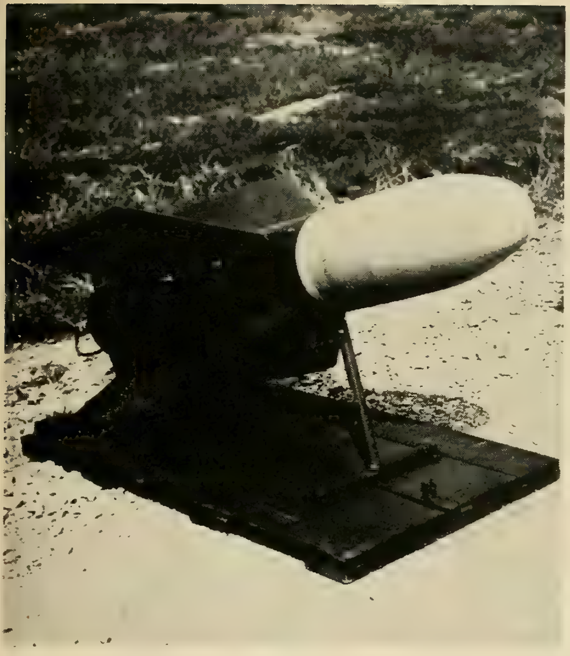


SS-11

SS-10, Army

TYPE: Antitank missile

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation, prime; GE, U.S. licensee

FRAME TYPE & CONFIGURATION: Length, 34 in.; diameter, 6 in.; wingspan, 30 in.; weight 33 lbs.; cruciform wings

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explosive shaped charge

PERFORMANCE: Range, 1,600 yds.; speed, 180 mph

REMARKS: In service with U. S. forces in Europe; being replaced with ENTAC; was battle-tested in North Africa

SS-11, Army

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

FRAME TYPE & CONFIGURATION: Length, 46 in.; diameter, 6 in.; wingspan, 20 in.; weight, 63 lbs.; swept-back cruciform wings

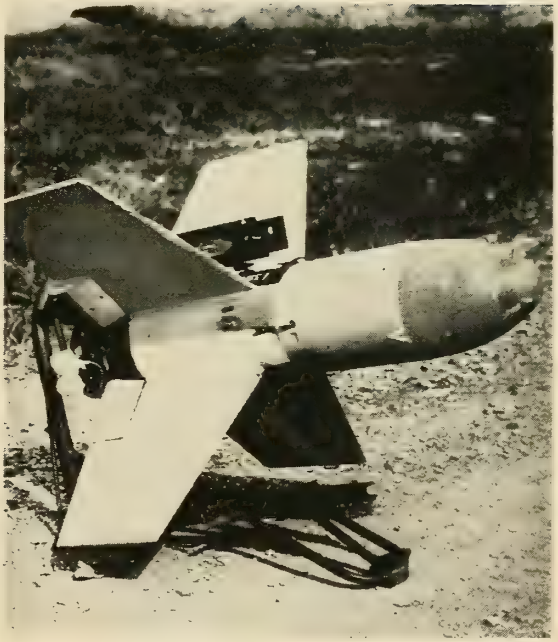
PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explosive shaped charge

PERFORMANCE: Range, 3,800 yds.; speed, over 400 mph

REMARKS: Can also be used in helicopter-to-ground missions; to be used by U.S. airborne and helicopter units



SS-10

Subroc (UUM-44), Navy

TYPE: Antisubmarine rocket

STATUS: Operational

PRIME CONTRACTOR: Goodyear

PROPULSION CONTRACTOR: Thiokol

PROPULSION TYPE: Solid rocket

GUIDANCE CONTRACTOR: General Precision/Aerospace

PAYLOAD: Nuclear or high-explosive warhead

EQUIPMENT CONTRACTORS: Librascope, fire control; AiResearch, auxiliary power

PERFORMANCE: Range, 25-30 miles

REMARKS: Fired from submarine torpedo tubes, leaves water in flight, re-enters water and seeks enemy submarine; first system was aboard Thresher, has reportedly been tested during U.S. nuclear test series in the Pacific

Titan I (HGM-25), Air Force

TYPE: Two-stage intercontinental ballistic missile

STATUS: Operational

PRIME CONTRACTOR: Martin Denver; STL, systems engineering and technical direction

FRAME TYPE & CONFIGURATION: Length, 98 ft.; diameter, first stage 10 ft., second stage 8 ft.; weight 220,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General Co.

PROPULSION TYPE: Liquid propellants, LOX RP-1; two engines first stage, one engine second stage; 300,000 lbs. thrust first stage, 80,000 lbs. thrust second stage

GUIDANCE CONTRACTOR: Bell Sperry

GUIDANCE TYPE: Radio-inertial

PAYLOAD: Nuclear warhead, yield about 15 megatons

GROUND EQUIPMENT CONTRACTORS: AMF, launch facilities; North American, transport vehicles

PERFORMANCE: Range, over 5,500 n. mi.; speed, 16,000 mph; apogee, 920 n. mi.

REMARKS: 54 missiles deployed at five bases

Titan II (LGM-25), Air Force

TYPE: Two-stage intercontinental ballistic missile

STATUS: Operational

PRIME CONTRACTOR: Martin Denver; STL, systems engineering and technical direction

FRAME TYPE & CONFIGURATION: Length, 103 ft.; diameter, 10 ft.; weight 330,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Liquid propellants, nitrogen tetroxide and a 50/50 mixture of hydrazine and unsymmetrical dimethylhydrazine; two engines first stage, one engine second stage; 430,000 lbs. thrust first stage; 100,000 lbs. thrust second stage

GUIDANCE CONTRACTOR: AC Spark Plug

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear warhead; about 20 megatons; re-entry vehicle, General Electric

GROUND EQUIPMENT CONTRACTORS: AMF, launch facilities; North American, transport vehicles

PERFORMANCE: Range, well over 5,500 n. mi.; speed, over 16,000 mph

REMARKS: Greatest payload & range of any U.S. ICBM; carries most sophisticated and effective penetration aids of any U.S. missile; constitutes basic core vehicle for Titan III; one squadron operational at Davis-Monthan AFB, Ariz.; to be used as Gemini space booster

Tow (Army)

TYPE: Antitank

STATUS: System Definition

PRIME CONTRACTOR: Hughes Aircraft

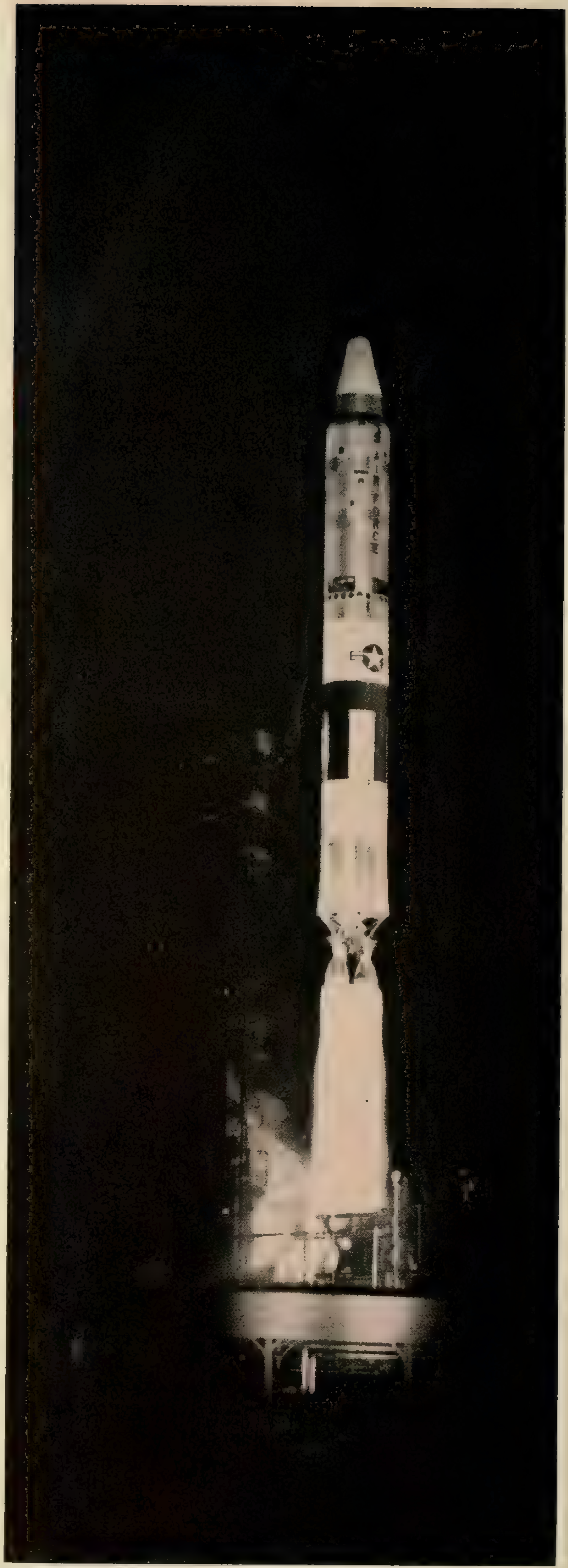
FRAME TYPE & CONFIGURATION: Tube-launched, optically-tracked, wire-guided

PROPULSION TYPE: Solid propellant

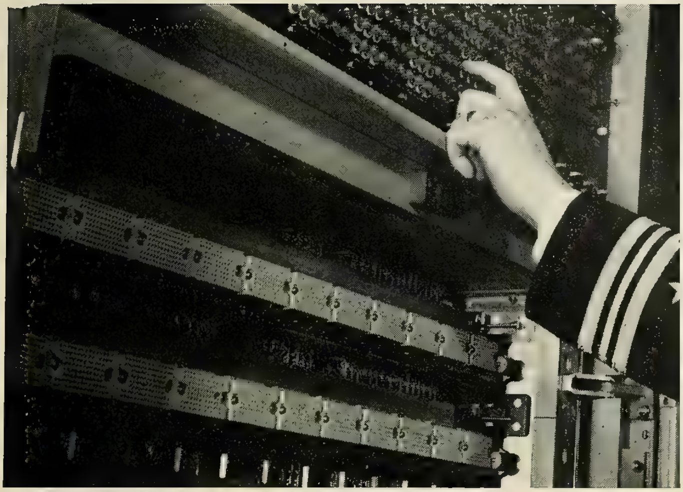
GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explosive shaped charge

REMARKS: Follow-on to ENTAC



TITAN II



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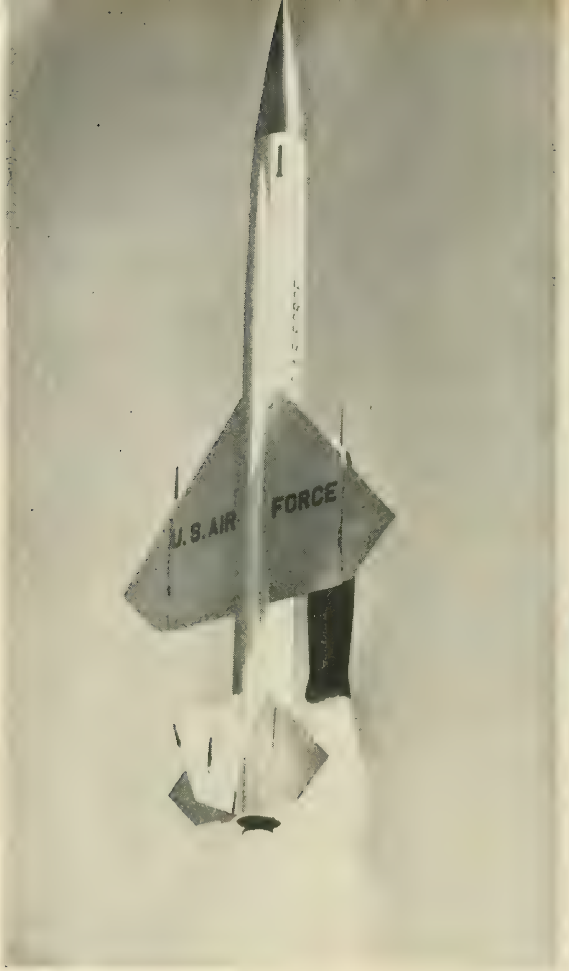

BOMARC

HAWK

Surface-to-Air

Bomarc B (AIM-10B), Air Force

TYPE: Pilotless interceptor

STATUS: Operational

PRIME CONTRACTOR: Boeing

FRAME TYPE & CONFIGURATION: Length, 45 ft.; wingspan, 18.2 ft.; diameter, 35 in.; weight, 16,000 lbs.

PROPULSION CONTRACTOR: Thiokol Marquardt

PROPULSION TYPE: Solid rocket booster/two ramjets

GUIDANCE CONTRACTOR: General Precision/Aerospace, IBM, Westinghouse

GUIDANCE TYPE: Command guidance via SAGE system, then homing to target

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., launcher/erector

PERFORMANCE: Range, over 400 n. mi.; speed, Mach 2.7

REMARKS: Three bases equipped with missile

Bomarc (AIM-10A), Air Force

TYPE: Pilotless interceptor

STATUS: Operational

PRIME CONTRACTOR: Boeing

FRAME TYPE & CONFIGURATION: Length, 46.9 ft.; wingspan, 18.2 ft.; diameter, 35 in.; weight 15,000 lbs.

PROPULSION CONTRACTOR: Aerojet/Marquardt

PROPULSION TYPE: Liquid rocket booster/ramjet sustainer

GUIDANCE CONTRACTOR: IBM/Westinghouse

GUIDANCE TYPE: Command via SAGE system, then homing to target

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., launcher/erector

PERFORMANCE: Range, over 200 n. mi.; speed, Mach 2.5; ceiling, over 68,000 ft.

REMARKS: Five bases operational in U.S.

Hawk (MIM-23), Army

TYPE: Dual-stage antiaircraft against low-flying planes

STATUS: Operational

PRIME CONTRACTOR: Raytheon Co.

FRAME CONTRACTOR: Nortronics, system contractor

FRAME TYPE & CONFIGURATION: Length, 16.8 ft.; diameter, 14 in.; weight, 1,275 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Solid propellant, dual stage

GUIDANCE CONTRACTOR: Raytheon

GUIDANCE TYPE: Semi-active radar homing

PAYLOAD: High-explosive warhead

GROUND EQUIPMENT CONTRACTORS: Mechanical GSE, Nortronics; guidance GSE, Raytheon; test equipment, RCA; launcher/loader/carrier, FMC Corp.; radar pedestals, Bendix; radar antennas, Goodyear

PERFORMANCE: Range, 22 mi.; speed, supersonic; ceiling, 100 to 45,000 ft.

REMARKS: Deployed in Europe, Panama, Okinawa, and the U. S.; bought by Sweden and Israel; advanced Hawk being developed for anti-tactical-missile use; has intercepted Corporal, Honest John and Little John rockets in flight

Alcoa's Carl Anderson speaks with authority on hollow extrusions in aircraft alloys.

This is the man who took the welds and weaknesses out of hollow extruded shapes

Carl Anderson is superintendent of Alcoa's big-press extrusion plant. With two 14,000-ton presses and a 3,000,000-lb stretcher at his command—plus his 20 years' experience in extrusion technology—he stays a step ahead of the competition and turns out a quality product that keeps other extruders of aluminum scratching their heads.

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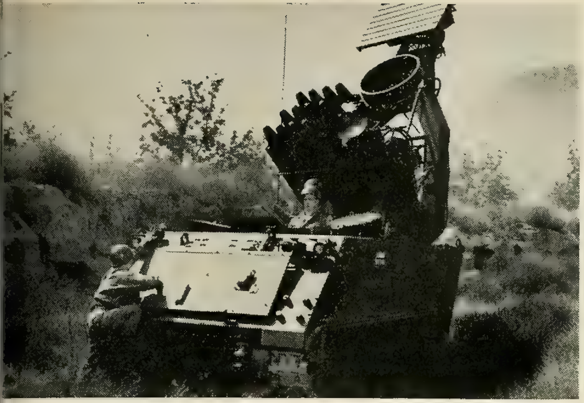


MAULER

Redeye (MIM-43), Army

TYPE: Shoulder-fired antiaircraft missile

STATUS: Development

PRIME CONTRACTOR: General Dynamics/Pomona

FRAME TYPE & CONFIGURATION: Bazooka-type, wingless cylindrical weapon; length, 44 in.; diameter, 2.75 in.; weight, 22 lbs.

PROPULSION CONTRACTOR: Atlantic Research Corp.

PROPULSION TYPE: Single-stage solid propellant

GUIDANCE CONTRACTOR: Philco/GD-Electronics

GUIDANCE TYPE: Infrared

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, classified; speed, supersonic

REMARKS: It's reported that disappointing system tests have caused postponement of production and deployment for about two years; no procurement funds in FY '64 budget; Marines also interested; weapon can be carried through terrain where no other air-defense system can go, even on tracked vehicles

Mauler (MIM-46), Army

TYPE: Fast, mobile antiaircraft/antimissile system

STATUS: Development

PRIME CONTRACTOR: General Dynamics/Pomona

FRAME CONTRACTOR: GD/Pomona

FRAME TYPE & CONFIGURATION: Dart-shaped; length, about 6 ft.; diameter, 5 in.; weight, 120 lbs.; each firing unit has nine missiles, 3 rows of 3 missiles each

PROPULSION CONTRACTOR: Lockheed Propulsion Co.

PROPULSION TYPE: Single-stage solid propellant

GUIDANCE CONTRACTOR: Hughes Aircraft, guidance; deHavilland of Canada, infrared acquisition system; Raytheon, radar; Burroughs, computer

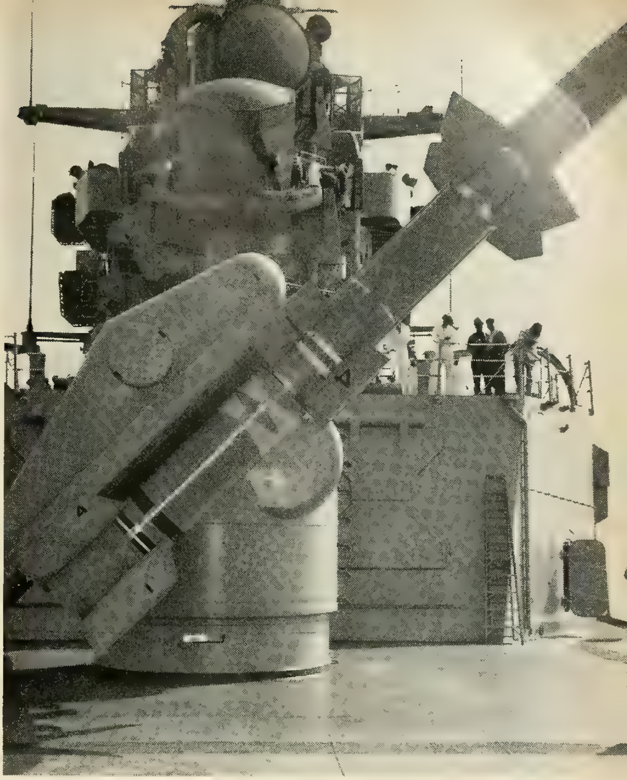
GUIDANCE TYPE: Sky-sweeping acquisition radar, target-illuminating pinpoint radar, then IR-homing for terminal phase

PAYLOAD: High-explosive warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., XM-546 self-propelled tracked vehicle

PERFORMANCE: Designed to rapidly engage and destroy enemy supersonic aircraft and rockets in the Honest John/Little John class while moving across a battlefield with front-line troops; details classified

REMARKS: Fully air-transportable; weapon pod contains all fire control and launch equipment as well as 9 missiles, can be removed for permanent emplacement if desired; system has three crew members, but can operate with two; Navy is planning a Sea Mauler version for deployment on tactical small craft; NATO may buy; FY '64 budget request is $83.3 million



TALOS

Sprint, Army

TYPE: Low-altitude anti-ICBM missile

STATUS: Development

PRIME CONTRACTOR: Martin/Marietta

FRAME TYPE & CONFIGURATION: Smaller than Nike-Zeus, but configuration unavailable

PROPULSION CONTRACTOR: Hercules/Lockheed

PROPULSION TYPE: Solid propellant; extremely high acceleration

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Command; will be mixed with Zeus missiles in batteries controlled by multi-function array radar; components must withstand tremendous g forces

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, classified; speed, classified; acceleration, extremely high

REMARKS: Will engage enemy ICBM's at relatively low altitudes to allow the atmosphere to strip away decoys and permit clearer discrimination by defensive radar; disadvantage is detonation of its nuclear warhead within the atmosphere, spreading fallout; nature of Sprint concept of defense is one factor which prompted Administration to seek a fallout shelter program

Talos (RIM-8), Navy

TYPE: Long-range fleet air defense; also shore-bombardment

STATUS: Operational

PRIME CONTRACTOR: Bendix/Mishawaka; Vitro, systems engineering

FRAME TYPE & CONFIGURATION: Two stages; overall length, about 30 ft.; diameter, about 30 in.; weight 7,000 lbs., 4,000 of which is 10-ft.-long booster

PROPULSION CONTRACTOR: Allegany Ballistics Laboratory

PROPULSION TYPE: Solid propellant booster/ramjet sustainer

GUIDANCE CONTRACTOR: Sperry

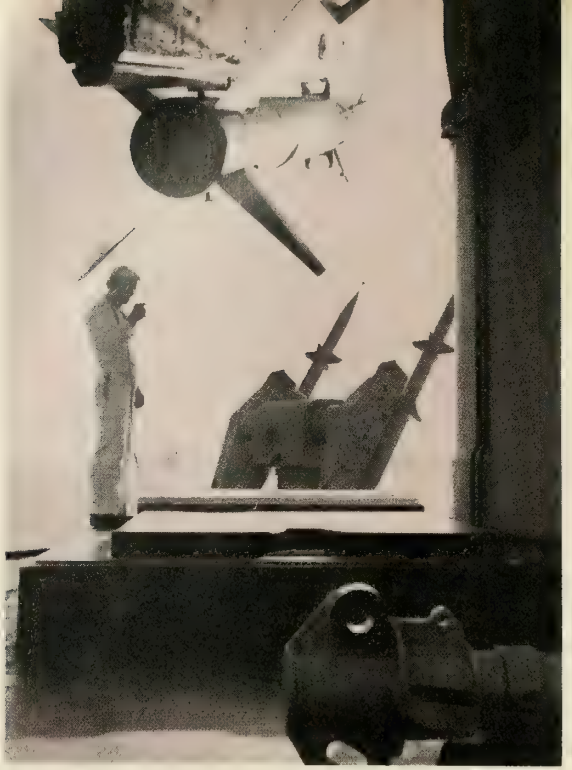
GUIDANCE TYPE: Dual; beam-riding to target area, then semiactive homing in terminal phase

PAYLOAD: Nuclear or high-explosive warhead

EQUIPMENT CONTRACTORS: Naval Weapons Plant, launchers; McDonnell, missile frame

PERFORMANCE: Range, over 65 n.mi.; speed, over Mach 2.5; ceiling, extremely high, figures unavailable

REMARKS: Operational aboard six cruisers, including nuclear-powered Long Beach; referred to by Adm. Arleigh Burke as "best (antiaircraft) missile in any arsenal in the world."



TERRIER

TARTAR

Tartar (RIM-24), Navy

TYPE: Fleet air defense

STATUS: Operational

PRIME CONTRACTOR: GD/Pomona; Vitro, systems engineering

FRAME TYPE & CONFIGURATION: Single-stage; length, 15 ft.; diameter, under 18 in.; weight, about 1,500 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Dual-burn solid propellant

GUIDANCE CONTRACTOR: Raytheon

GUIDANCE TYPE: Radar beam-riding

PAYLOAD: High-explosive warhead

EQUIPMENT CONTRACTORS: Launcher, Puget Sound Naval Shipyard; handling equipment, Naval Weapons Plant/Washington Technological Associates

PERFORMANCE: Range, over 10 n.mi.; speed, Mach 2

REMARKS: Deployed aboard 15 destroyers and cruisers equipped with Talos; primary air-defense weapon for destroyers, secondary defense for cruisers

Terrier (RIM-2), Navy

TYPE: Fleet air defense

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Pomona; Vitro, systems engineering

FRAME TYPE & CONFIGURATION: Two-stage; overall length, 27 ft., with 12-ft. booster; diameter, about 1 ft.; weight, about 3,000 lbs.

PROPULSION CONTRACTOR: Allegany Ballistics Laboratory/Naval Propellant Plant

PROPULSION TYPE: Two-stage; solid-propellant booster & sustainer

GUIDANCE CONTRACTOR: General Dynamics/Pomona, guidance section; Sperry, radar

GUIDANCE TYPE: Radar beam-riding or homing

PAYLOAD: High-explosive warhead

EQUIPMENT CONTRACTOR: Northern Ordnance, Inc., launchers & power drives

PERFORMANCE: Range, over 10 n.mi.; speed, Mach 2.5; ceiling, over 65,000 ft.

REMARKS: Operational aboard two attack carriers, 6 cruisers and 12 frigates; other frigates under construction will use it; advanced version has better coverage and improved guidance; Marines use Terrier with mobile land launchers

TYPHON

Typhon (RIM-50/RIM-55), Navy

TYPE: Fleet air defense in two versions

STATUS: Development

PRIME CONTRACTOR: Bendix & GD/Pomona, missile and missile electronics

FRAME TYPE & CONFIGURATION: Medium- and long-range versions to replace Talos, Tartar & Terrier; configuration of each version unavailable

PROPULSION CONTRACTOR: McDonnell

PROPULSION TYPE: Solid rocket booster/ramjet sustainer

GUIDANCE CONTRACTOR: Westinghouse, weapons direction and radar

PAYLOAD: Nuclear or high-explosive warhead

PERFORMANCE: Range, estimated 200 n.mi.; speed and ceiling classified; believed to have antimissile capabilities

REMARKS: Long-range version (RIM-50) will replace Talos and medium-range version (RIM-55) will replace Tartar and Terrier for fleet air defense; system encountering development problems and DOD insists on extensive testing and proof of effectiveness before approving deployment; USS Norton Sound will act as testbed for seagoing trials

U. S. Spacecraft	Launch Vehicle	Remarks
Mercury	Atlas D	Two 3-orbit and one 6-orbit manned missions successful; 18-22 orbit mission planned.
Gemini	Titan 2 ✓	Rendezvous techniques development; 14-day mission with 2 men; continued development of spacecraft technology; USAF sharing cost.
Apollo A ✓	Saturn 1	14-day earth orbit test of 3-man command module.
	Saturn 1B	Earth-orbit test of rendezvous of command and service modules with lunar excursion module (LEM).
Apollo B ✓	Saturn 5	Circumlunar flight with command and service modules.
	Saturn 5	Tentative lunar orbit mission to drop LEM loaded with supplies for landing mission to follow.
Apollo C ✓	Saturn 5	Lunar orbit of composite spacecraft with 3 men, followed by descent to surface in two-man LEM and exploration.
Lunar Excursion Module (LEM) ✓	Saturn 5	Vehicle to land two men on lunar surface from lunar orbit.
X-20 (Dyna-Soar)	Titan 3C ✓	Hypersonic glide re-entry research in one-man vehicle.
Manned Orbital Development Station (MODS)	....	Under study.
Manned Orbital Space Station (MOSS)	Saturn 5	Possible 12-man long-life station under study.
Tiros	Delta ✓	IR studies and photography of clouds for meteorological satellite development.
Nimbus	Thor-Agena B ✓	First operational meteorological satellite.
Synchronous Meteorological Satellite (SMS)	....	Formerly called Aeros.
Echo 2	Thor-Agena B ✓	Passive communications satellite with 135-ft. diameter rigidized sphere.
Telstar	Delta ✓	AT&T funded project to develop wide-band commercial communications satellite.
Relay	Delta ✓	Feasibility tests of low-altitude, one-way active repeater satellite.
Syncom	Delta ✓	Lightweight two-way active repeater satellite in synchronous orbit.
Advanced Syncom	Atlas-Agena B ✓	Larger, more sophisticated follow-on to Syncom 1. Hughes has study contract.
Medium-Altitude Random-Orbit Comsat	Atlas-Agena B ✓	Air Force planned system of random-orbit comsats to be launched in groups of up to 8 satellites.
Oscar	Thor-Agena B ✓	Non-governmental comsat for amateur radio operators; piggy-back launches with Discoverer satellites.
Transit	Thor-Ablestar ✓	Orbiting navigation beacon development.
Agena D Gemini Target ✓	Atlas D	Rendezvous target for 2-man Gemini spacecraft.
Ranger	Atlas-Agena B ✓	Lunar impact; high-resolution photography; landing of survivable instrument capsules on the moon.
Surveyor Lander	Centaur	Unmanned lunar lander with payload for examination of lunar crust and environment.
Surveyor Orbiter	Centaur	Selenodetic satellite for lunar reconnaissance and photographic mapping; to monitor lunar radiation.
Mariner 1, 2	Atlas-Agena B ✓	Scaled-down Mariner A spacecraft which successfully completed Venus fly-by on Dec. 14, 1962, taking magnetometer and radiometer data.
Mariner B	Centaur	Advanced, heavier version of Mariners 1 and 2 which will drop survivable instrument capsules to the surface of Mars and Venus.
Mariner C	Atlas-Agena D ✓	Mars fly-by vehicle.
Voyager	Saturn 1B	Mars/Venus orbiter.
Solar Probe	Atlas-Agena B ✓	Designed to come within 0.2 A.U. of the sun's surface for close-up observations.
Pioneer	Delta ✓	Solar-orbiting spacecraft (perihelion 0.8 A.U., aphelion 1.2 A.U.) for measurements during the International Quiet Sun Year. Formerly known as PIQSY.
Outer Planets Spacecraft	....	Fly-bys and orbitings of the Jovian planets.
Out-of-Ecliptic Plane Spacecraft	....	Investigations of phenomena out of the ecliptic plane.
Interstellar Probe	....	Solar system escape spacecraft.
Discoverer Series	Thor-Agena A, B ✓	Development of Agena vehicle and test of designs, techniques and components for military and scientific satellites.
Explorer Series	Juno; Scout ✓; Delta ✓	General name for NASA scientific earth satellites. Explorer 1 was first U.S. satellite.
Orbiting Astronomical Observatory (OAO)	Atlas-Agena B ✓	Orbiting telescope for mapping of heavens in UV spectrum.
Orbiting Geophysical Observatories:	.... ✓	Study of radiation belts, magnetic fields and ionosperic phenomena.
EGO S-49	Atlas-Agena B ✓	Eccentric-orbiting geophysical observatory.
POGO S-50	Thor-Agena B ✓	Polar-orbiting geophysical observatory.
Orbiting Solar Observatory (OSO)	Delta ✓	Study of solar UV and X-radiation.
Helios	Thor-Agena B ✓	Advanced orbiting solar observatory; to study particle radiation as well as electromagnetic radiation.
ANNA 1-B	Thor-Ablestar ✓	Joint Army-Navy-NASA-Air Force geodetic satellite.
Injun	Thor-Ablestar ✓	Investigation of earth's radiation belts.
Greb (SR Series)	Thor-Ablestar ✓	Study of solar and cosmic radiation.
Traac	Thor-Ablestar ✓	Test of gravity-gradient stabilization system for Transit satellites.
Arents	Atlas-Agena B ✓	Advanced research environment test satellite to study environmental conditions and radiation in synchronous orbit.
TRS-1	....	Radiation belt mapping.
Bios 2	Atlas-Agena B ✓	Long-term exposure of primates and other biological specimens; recovery by ejected capsule.
Lofti	Thor-Ablestar ✓	Test of propagation of very low frequency radio signals in ionosphere.
Energetic Particles Satellites:	....	Measurement of artificial radiation created by high-altitude nuclear blasts.
S-3a (Explorer 14)	Delta ✓	
S-3b (Explorer 15)	Delta ✓	
Atmospheric Structures Satellite S-6	Delta ✓	Study of composition, density, pressure and temperature of upper atmosphere.
Fixed-Frequency Topside Ionosphere Sounder S-48	Scout	Study of ionosphere from above by measuring electron distribution, electron density and cosmic noise level.
Micrometeoroid Detector Satellite S-55 (Explorer 16)	Scout	Study of spatial-temporal distribution of micrometeoroids as hazard to spaceflight.
Polar Ionosphere Beacon S-66	Delta ✓	Study of ionosphere behavior and electron content, as well as conditions which disrupt communications.
Interplanetary Monitoring Platform (IMP) S-74	Delta ✓	Ascertain Project Apollo radiation hazards; increase solar flare prediction capability; study solar-terrestrial relationships.
Large Micrometeoroid Detector Satellite	Saturn 1	Obtain better statistical information of meteoroid distribution with larger area. To be flown in boilerplate command module during a test of Saturn 1 booster.

Excerpts from AVIATION WEEK & SPACE TECHNOLOGY 1963 International Aerospace Spec Tables

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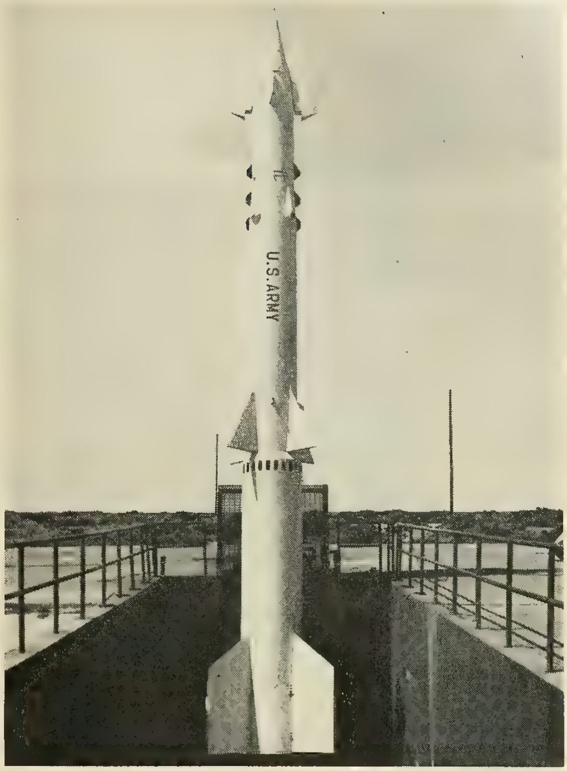
NIKE-HERCULES



NIKE-ZEUS

Nike-Hercules (MIM-14), Army

TYPE: Two-stage high-altitude antiaircraft missile

STATUS: Operational

PRIME CONTRACTOR: Western Electric Co.

FRAME CONTRACTOR: Douglas Aircraft Co.

FRAME TYPE & CONFIGURATION: Length, 41 ft.; diameter, 31.5 in.; weight, 10,000 lbs.

PROPULSION CONTRACTOR: Hercules/Thiokol

PROPULSION TYPE: Two-stage solid propellant

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Command; system uses low-power acquisition, high-power acquisition, target-tracking, and missile-tracking radars in conjunction with electronic data-processing gear

PAYLOAD: Nuclear or high-explosive warhead

GROUND EQUIPMENT CONTRACTORS: Launchers, Consolidated Western Steel; transport vehicles, Fruehauf; ground guidance, Western Electric

PERFORMANCE: Range, over 75 n. mi.; ceiling, over 150,000 ft.; speed, over Mach 3

REMARKS: Over 80 batteries deployed in U.S.; 10 batteries deployed overseas in Europe and on Taiwan; being equipped with Hipar, a high-power acquisition radar, for anti-tactical ballistic missile capabilities; has knocked down other ballistic missiles and other Nike-Hercules missiles

Nike-X, Army

TYPE: Dual-missile anti-ICBM system

STATUS: Development

PRIME CONTRACTOR: Western Electric Co.

FRAME TYPE & CONFIGURATION: Douglas, Zeus frame; Martin-Orlando, Sprint frame; Sprint is smaller than Zeus but its configuration is unknown

PROPULSION CONTRACTOR: Thiokol/Lockheed, Zeus propulsion; Hercules/Lockheed, Sprint propulsion

PROPULSION TYPE: Solid propellants; three Zeus stages; Sprint configuration unknown

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Command; will use MAR (multi-function array radar) instead of three separate radars for acquiring & tracking both target and missile as regular Zeus system does; MAR will acquire & track both target and missile

PAYLOAD: Nuclear warheads for both Zeus and Sprint

PERFORMANCE: Zeus—range over 200 n. mi.; speed, over Mach 4; Sprint—classified, but extremely high acceleration required

REMARKS: Nike-X is advanced version of Nike-Zeus, using advanced MAR radar and Sprint missile to greatly enhance capabilities against ICBM's of 1970's; each Nike-X battery may contain mix of Zeus and Sprint missiles to allow flexibility in engaging enemy warheads at high (Zeus) or low (Sprint) altitudes; system can acquire, track, and engage a number of targets simultaneously, firing either missile from "mix" available; new computers will allow greater speed and data-handling capacity; new elements involved are still in design stages, and complete system is not expected to be tested for some time, although components will be tested in the Zeus program at Kwajalein and White Sands Missile Range

Nike-Zeus (LIM-49), Army

TYPE: Three-stage anti-ICBM

STATUS: Advanced development

PRIME CONTRACTOR: Western Electric Co.

FRAME CONTRACTOR: Douglas Aircraft Co.

FRAME TYPE & CONFIGURATION: Length, 48.3 ft.; diameter, (sustainer) 36 in.; fin span, 10 ft.; launch weight, 22,800 lbs.

PROPULSION CONTRACTOR: Thiokol/Lockheed

PROPULSION TYPE: Three-stage solid propellant, with "jet-head" system for manuevering in space; acceleration very high

GUIDANCE CONTRACTOR: Western Electric Co.

GUIDANCE TYPE: Command; system uses acquisition radar, target-track radar and missile-track radar in conjunction with electronic data-processing gear

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: Goodyear Aircraft, acquisition radar antennas; Allis-Chalmers/Continental Can/NARMCO, target-track antenna; Steel Products Engineering, missile-track antenna; Remington Rand Univac, computers; Burns & Roe, Inc., technical facilities design; Stromberg Carlson, test sets

PERFORMANCE: Slant range, about 200 n. mi.; speed, over Mach 4

REMARKS: Downgraded in favor of Nike-X; continued development planned with $89 million funding in FY '64; has made a number of successful intercepts

FALCON

Air-to-Air

Falcon (AIM-4/AIM-26/AIM-47), Air Force

TYPE: Variety of aerial combat missiles

STATUS: Operational

PRIME CONTRACTOR: Hughes Aircraft

FRAME TYPE & CONFIGURATION: Single-stage; length, 6.5 ft.; diameter, 6 in.; weight, over 100 lbs. (for all except AIM-26); AIM-26 length, about 7 ft.; diameter, 11 in.; weight, over 200 lbs.; fin span, 20 in.

PROPULSION CONTRACTOR: Thiokol for all except AIM-47 Lockheed Propulsion for AIM-47

PROPULSION TYPE: Solid propellant; thrust varies with missile, but is about 6,000 lbs.

GUIDANCE CONTRACTOR: Hughes

GUIDANCE TYPE: Varies with missile: active radar homing/infrared homing/hybrid IR-radar homing

PAYLOAD: Nuclear warhead on AIM-26; high-explosive warhead on remainder

PERFORMANCE: Range, over 5 n.mi.; speed, supersonic; ceiling, above 50,000 ft.

REMARKS: Missiles formerly designated GAR-1, 2, 3 and 4 now AIM-4; GAR-11 now AIM-26; GAR-9 now AIM-47; series deployed with F-89; F-101, F-102 and F-106 aircraft; procurement for most versions completed; AIM-47 under minimum-effort development

Genie (AIR-2), Air Force

TYPE: Nuclear armament for interceptors

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co.

FRAME TYPE & CONFIGURATION: Length, 9.5 ft.; diameter, 17.35 in.; weight, 800 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Nuclear warhead with proximity fuzing

PERFORMANCE: Range, over 6 n.mi.; speed, about Mach 3; ceiling, above 50,000 ft.

REMARKS: Improved version cancelled; originally intended to destroy bomber formations, a threat now felt declining

Phoenix (AIM-54), Navy

TYPE: Airborne armament for F-111B (TFX) aircraft

STATUS: Development

PRIME CONTRACTOR: Hughes Aircraft

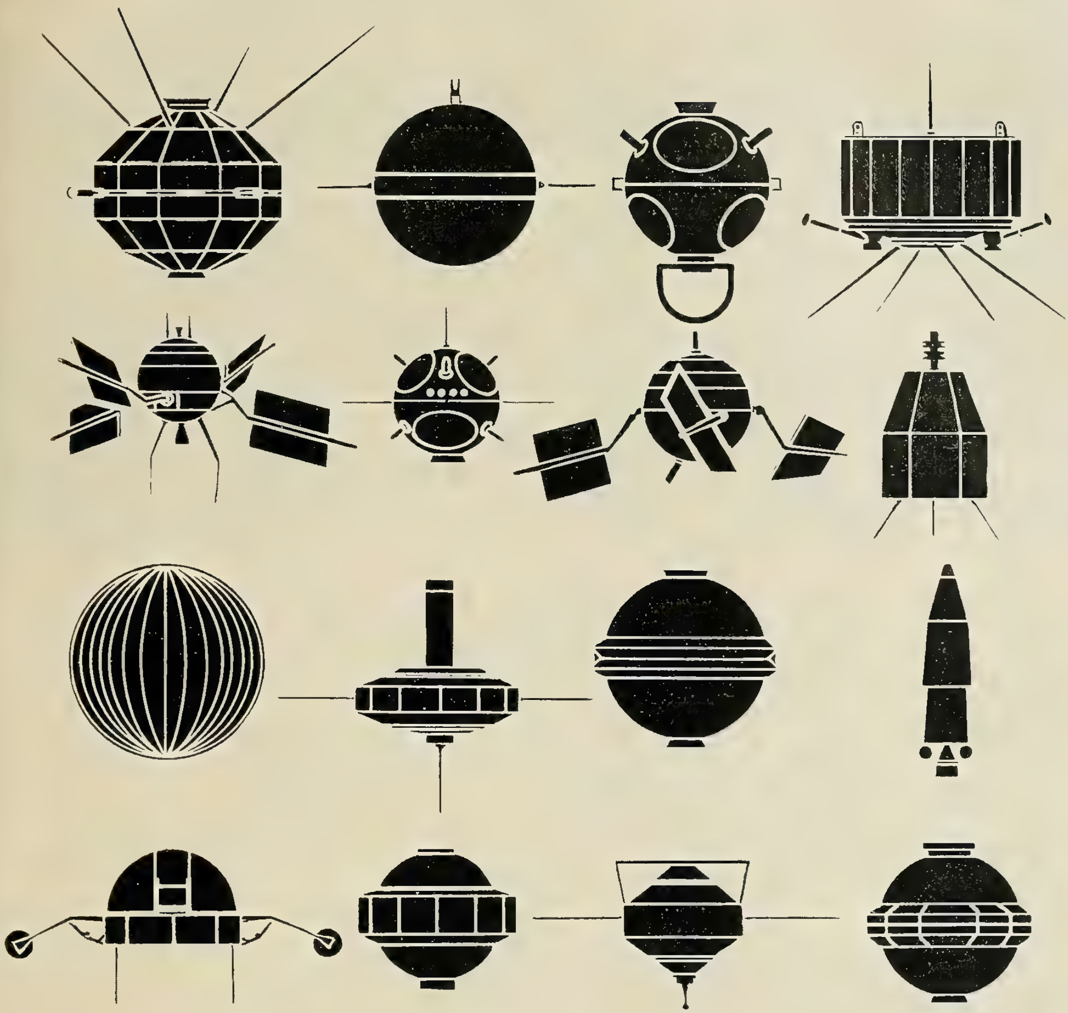
PROPULSION TYPE: Single-stage, dual-burn solid propellant

GUIDANCE CONTRACTOR: Hughes Aircraft

PAYLOAD: High-explosive warhead

PERFORMANCE: Details classified, but extensive range and altitude capabilities required

REMARKS: Reportedly similar to cancelled Eagle missile which was to be used with Missileer long-duration aircraft; Hughes has $12.2-million development contract



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(they all use Sonotone nickel-cadmium batteries)

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Greb II
Tiros III
Transit IV-B
TRAAC
Tiros IV
OSO-1
Tiros V
Tiros VI
Alouette
Anna I-B
Relay
Transit V-A
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Next?

(Can you pick out the 16 illustrated above?)

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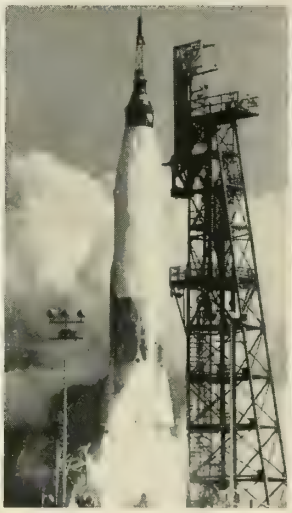
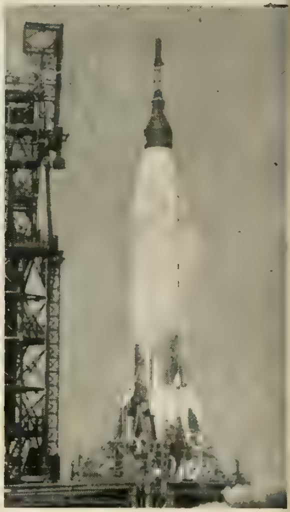
Perfect Atlas Record in Launching Manned Mercury Orbital Flights...

MA-6


MA-7

MA-8


MA-9

RELIABILITY SUMMARY–Here are some of the specifics which contributed to the Atlas-Mercury 100% success:

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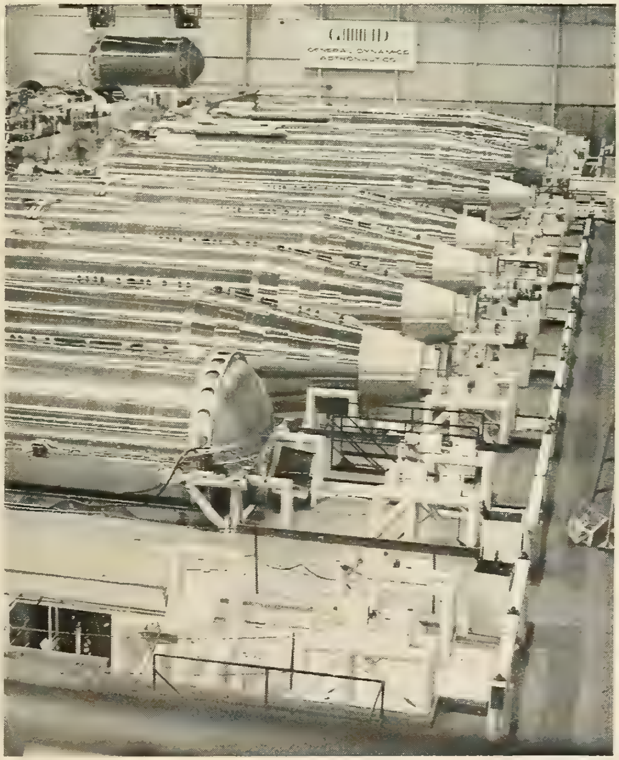


GENERAL DYNAMICS

ASTRONAUTICS DIVISION

SAN DIEGO, CALIFORNIA

SIDEWINDER

Sidewinder (AIM-9), Navy, Air Force

TYPE: Airborne armament for interceptors

STATUS: Operational

PRIME CONTRACTOR: Philco/GE

FRAME TYPE & CONFIGURATION: Length, 9 ft.; diameter 5 in.; weight, about 155 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Philco/GE

GUIDANCE TYPE: Infrared on original version; interchangeable IR and radar on improved version

PAYLOAD: High-explosive warhead

EQUIPMENT CONTRACTORS: Norris-Thermador/Hunter-Douglas, missile components; Motorola, guidance components

PERFORMANCE: Range, over 2 n.mi.; speed, supersonic; ceiling, over 50,000 ft.

REMARKS: In use by Navy, Air Force; NATO-built version under test; highly successful during Quemoy crisis when used by Chinese Nationalists against Red Chinese MIGs

Sparrow III (AIM-7), Navy

TYPE: Airborne armament for interceptors

STATUS: Operational

PRIME CONTRACTOR: Raytheon

FRAME TYPE & CONFIGURATION: Length, about 12 ft.; diameter, 8 in.; weight, about 350 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Solid propellant in some versions, pre-packaged liquid in others

GUIDANCE CONTRACTOR: Raytheon

GUIDANCE TYPE: Semiactive CW homing

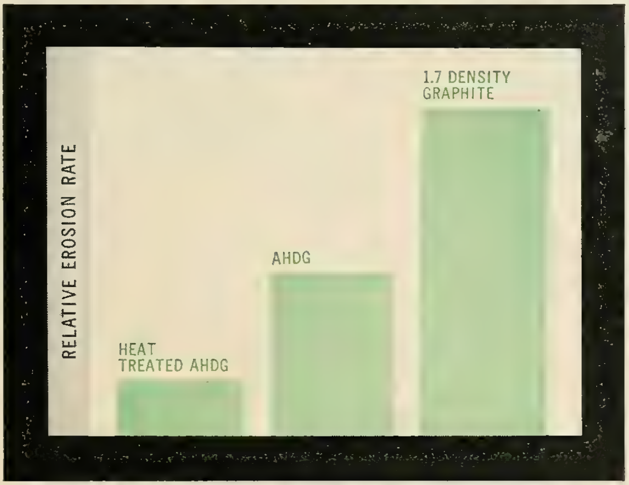
PAYLOAD: High-explosive warhead

PERFORMANCE: Range, 8 n.mi.; speed, Mach 3; ceiling, over 50,000 ft.

REMARKS: Deployed on carrier aircraft; prime armament on F4H interceptors; Sparrow III and IIIA in use, Sparrow IIIB under development

SPARROW III

Heat Treated AHDG high-performance GRAPHITE



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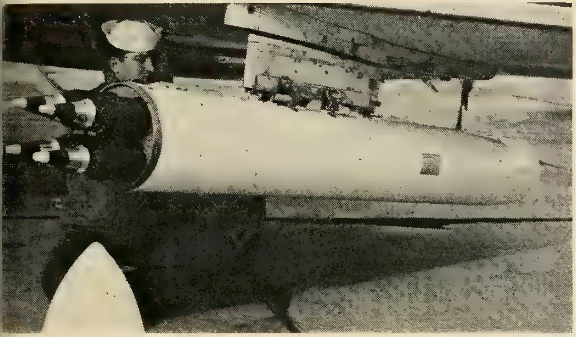
Air-to-Surface

SHRIKE


ZUNI

Bullpup (AGM-12), Navy, Air Force

TYPE: Tactical air support

STATUS: Operational

PRIME CONTRACTOR: Martin Co.; Maxson Electronics Corp., second-source prime

FRAME TYPE & CONFIGURATION: Essentially a guided, powered bomb; length, 11 ft.; diameter, 12 in.; weight, 573 lbs.

PROPULSION CONTRACTOR: Thiokol/Naval Propellant Plant

PROPULSION TYPE: Solid propellant; Bullpup B has prepackaged liquid propellant

GUIDANCE CONTRACTOR: Martin Co.

GUIDANCE TYPE: Radio-link command guidance from firing aircraft, pilot uses visual reference

PAYLOAD: High-explosive warhead in various sizes from 250-1,000 lb. bomb; nuclear warhead on Bullpup B

PERFORMANCE: Range, 6 n.mi. (depending on launch altitude of aircraft); speed, 1,400 mph.; extremely accurate against hard-point targets

REMARKS: Deployed in considerable numbers with Navy fleets and Air Force units

Hound Dog (AGM-28), Air Force

TYPE: Strategic defense-suppression missile

STATUS: Operational

PRIME CONTRACTOR: North American Aviation

FRAME TYPE & CONFIGURATION: Air-breathing cruise type; length, 42.5 ft.; wingspan, 12.2 ft.; height, 9.3 ft.; weight, 9,600 lbs.

PROPULSION CONTRACTOR: Pratt & Whitney

PROPULSION TYPE: J52 turbojet generating 7,500 lbs. thrust at sea level

GUIDANCE CONTRACTOR: Autonetics Div., NAA

GUIDANCE TYPE: All-inertial

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, over 600 n.mi.; speed, over Mach 2; ceiling, over 50,000 ft.

REMARKS: Originally standoff weapon of lower priority than Skybolt, Hound Dog will now be retained in SAC arsenal for suppression of enemy defenses so that B-52 bombers can penetrate to top-priority targets with primary bomb load; stockpile expected to exceed 400 to compensate for Skybolt cancellation

Quail (ADM-20), Air Force

TYPE: Decoy to simulate B-52 bombers

STATUS: Operational

PRIME CONTRACTOR: McDonnell Aircraft Corp.

FRAME TYPE & CONFIGURATION: Length, 12.9 ft.; height, 3.3 ft.; wingspan, 5.5 ft.; width (with wings folded), 2.5 ft.

PROPULSION CONTRACTOR: General Electric

PROPULSION TYPE: J85 turbojet generating 2,450 lbs. thrust

GUIDANCE CONTRACTOR: Guidance Technology, Inc.

GUIDANCE TYPE: Gyroscopic autopilot

PAYLOAD: B-52 electronic simulation and electronic countermeasures equipment

EQUIPMENT CONTRACTORS: Thompson-Ramo-Wooldrigde, electronic payload; support system contractor, Bell Aerospace

PERFORMANCE: Range, 250 n.mi.; advanced version, over 400 n.mi.; speed, comparable to B-52; ceiling, over 50,000 ft.

REMARKS: Each B-52 bomber carries Quail decoys to release as it approaches enemy defenses; bomber and decoys fly B-52-style patterns, speeds and altitudes over wide area to maximize enemy confusion

Shrike (AGM-45), Navy

TYPE: Anti-radar missile

STATUS: Development

PRIME CONTRACTOR: Naval Ordnance Test Station-China Lake

FRAME TYPE & CONFIGURATION: Similar to Sparrow III configuration; details unavailable

PROPULSION CONTRACTOR: NOTS/China Lake

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Texas Instruments

GUIDANCE TYPE: Passive radar-homing

PAYLOAD: High-explosive warhead

REMARKS: Designed for firing by tactical aircraft against enemy radar-controlled defenses and other radar installations

Walleye, Navy

TYPE: Glide Bomb

STATUS: Development

PRIME CONTRACTOR: Naval Ordnance Test Station/China Lake

FRAME TYPE & CONFIGURATION: 1,000-lb. bomb; no configuration details available, except equipped with movable fins

PROPULSION TYPE: None

GUIDANCE CONTRACTOR: Naval Ordnance Test Station/China Lake

GUIDANCE TYPE: Homing

PAYLOAD: High-explosive warhead

REMARKS: Few operating details available, but Navy says to be "most accurate and effective air-to-surface conventional weapon ever developed anywhere."

Zuni, Navy

TYPE: Heavy bombardment of ground targets

STATUS: Operational

PRIME CONTRACTOR: Naval Ordnance Test Station/China Lake

FRAME TYPE & CONFIGURATION: Folding fin, all-weather rocket; length, 9.2 ft.; diameter, 5 in.; weight, 107 lbs.

PROPULSION CONTRACTOR: Hunter-Douglas

PROPULSION TYPE: Solid propellants

GUIDANCE TYPE: Unguided

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, about 5 n.mi.; speed, over Mach 2

REMARKS: Used on many Navy attack and fighter aircraft; AD-type can carry 48; extremely effective as a barrage rocket against ground targets

Drones

Bikini, Photo Recon Drone

MISSION: Provide battlefield commanders with small, lightweight, photo reconnaissance drone

STATUS: Development

PRIME CONTRACTOR: Republic Aviation Corp.

PERFORMANCE: Max. speed—below 115 mph; Endurance—30-40 min.; Altitude—roughly 5,000 ft:, Range—recon radius, 5-10 mi.

CONFIGURATION: Experimental but resembles large model airplane; Weight—approx. 35 lbs. including camera payload; Major Materials—reinforced plastic and off-the-shelf model airplane parts. Vertical stabilizer extends below fuselage

GUIDANCE: Radio Command; 5-channel for aileron, rudder, throttle setting, camera activation and recovery parachute deployment

PROPULSION: Propeller, under 5 hp.; 2-cycle, 2 cylinder engine

REMARKS: Low-cost vehicle system designed to complement Army's USD-2 drone. Can be operated throughout mission by 2 men

Firebee, Target Drone (Navy)

MILITARY DESIGNATION: AQM-34B, AQM-34C

STATUS: Operational

PRIME CONTRACTOR: Ryan Aeronautical Co.

PERFORMANCE: Max. Speed—575 mph; Service Ceiling—40,000 ft.; Endurance—60 min.

CONFIGURATION: Span—135 in.; Length—211 in.; Height—75 in.; Max. weight—1,848 lbs.

GUIDANCE: Radio command and radar

PROPULSION SYSTEM: One Continental J-69-T-19 engine with 1,000 lbs. thrust (AQM-34B); one Fairchild J-44-R-20 engine with 1,000 lbs. thrust (AQM-34C-4)

SUPPORT EQUIPMENT: Air- or ground-launched; recoverable by parachute

Firebee, Target Drone (Air Force)

MILITARY DESIGNATION: BQM-34A

STATUS: Operational

PRIME CONTRACTOR: Ryan Aeronautical Co.

PERFORMANCE: Max. Speed—625 mph; Service ceiling—59,800 ft.; Endurance—75 to 96 min. at 50,000 ft.

CONFIGURATION: Span—153 in.; Length—274 in.; Height—79 in.; Max. weight—2,500 lbs.

GUIDANCE: Radio command and radar

PROPULSION SYSTEM: One Continental J-69-T-29 with 1,700 lbs. thrust

SUPPORT EQUIPMENT: Air- or ground-launched; recoverable by parachute

REMARKS: Army and Navy also use system; Primary using commands are Air Defense Command and the Systems Command

MQM-15A Target Drone (Army)

STATUS: Operational

PRIME CONTRACTOR: Ling-Temco-Vought Corp.

PERFORMANCE: Not available

CONFIGURATION: Span—240 in.; Length—684 in.; Diameter (body)—72 in.

GUIDANCE: Not available

PROPULSION SYSTEM: Booster—Aerojet 115,000-lb.-thrust solid-propellant motor. Sustainer—One General Electric J79 engine with afterburner

REMARKS: Target version of the Regulus II missile; limited production; flown as a target against air defense missile systems. Navy shipboard version designated RGM-15A

MQM-39A Target Drone (Navy)

MISSION: Provides "out of sight" target for surface-to-air and air-to-air missiles

STATUS: Operational

PRIME CONTRACTOR: Beech Aircraft Corp.

PERFORMANCE: Max. speed—340 mph; Service ceiling—40,000 ft.; Endurance—60 min.

CONFIGURATION: Span—155 in.; Length—180 in.; Diameter (body)—17¾ in.; Weight—635 lbs.

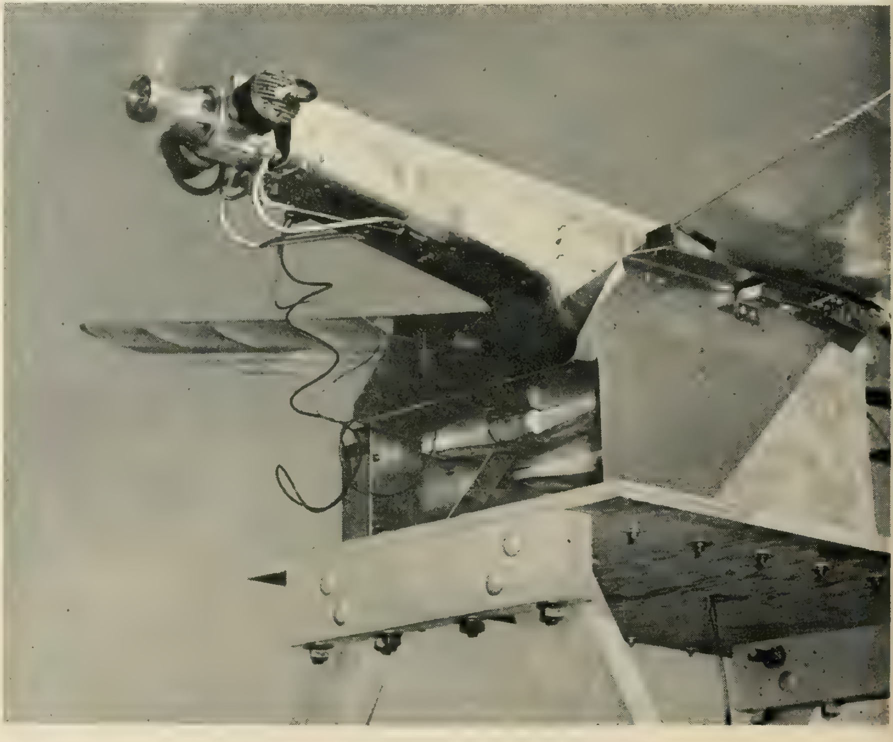
GUIDANCE: Radio command

CONTROL SYSTEM: Two-axis Guidance Technology, Inc. gyroscope autopilot

PROPULSION SYSTEM: One McCullough turbo-supercharged, 125-hp engine

SUPPORT EQUIPMENT: Launched from zero-length launcher or aircraft; parachute-recovered

REMARKS: An advanced target drone with the same dimensions but enhanced performance has also been built by Beech. Designated the PD75-4-1, the only major difference between the two is that the PD 75 uses a 145-hp, four-cylinder Continental TS10-200 engine. MQM-39A also used by Army, Air Force



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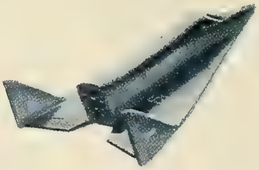

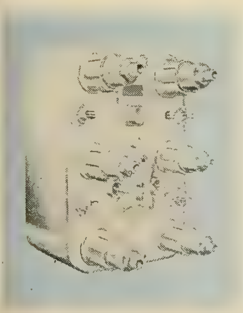

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SCIENTIFIC PROBLEM-SOLVING:

Remote Area Conflict

The Research Analysis Corporation has been expanding its activities in the field of Remote Area Conflict (encompassing counterinsurgency, guerrilla and counterguerrilla action and other types of irregular and unconventional warfare). As a consequence, RAC can now offer outstanding new career opportunities for work in scientific problem-solving of high challenge and complexity.

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Research Analysis Corporation

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MQM-33B, Aerial Target (Army, AF); MQM-36A (Navy)

MISSION: Target for gunnery and missile training and evaluation

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max. Speed—220 mph; Stalling speed—70 mph; rate of climb—3,350 fpm; service ceiling—23,000 ft.; endurance—60 min.

CONFIGURATION: Span—138.0 in. with pods 158.5 in.; length—147.0 in.; height—31.3 in.; total weight—326.8 lbs., with pods, 353 lbs.

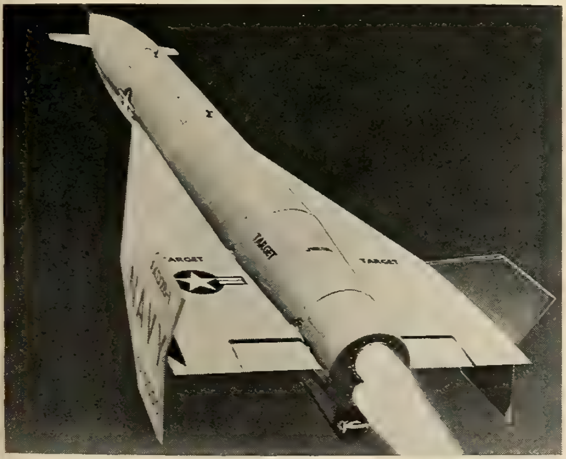
FLIGHT CONTROL: RPS-1A vhf command control system (MQM-33B); C-24 uhf proportional command control system with automatic stabilization (MQM-36A)

PROPULSION SYSTEM: 2-cycle, 4-cylinder, flat-opposed, air-cooled, McCulloch Motors engine, driving a fixed-pitch, 44-in.-dia. wooden propeller. Fuel capacity 11.3 gal.

PAYLOAD: For radar appearance augmentation two wing-tip reflector pads are added to MQM-33A; standard on MQM-33B and MQM-36A

SUPPORT EQUIPMENT: MQM-33A, ground- or air-launched; MQM-36A, ground-launched only; catapult, rotary or zero-length launchers used; single parachute 38-ft.-dia. (MQM-33A) or 32-ft. used for recovery

REMARKS: New model incorporates six-cylinder engine for increased performance



AQM-37A DRONE

AQM-35B, Target Drone (Air Force)

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max. Speed—Mach. 2; service ceiling—70,000 ft.; endurance—60 min.

CONFIGURATION: Span—156 in.; length—432 in.; max. weight—3,350 lbs.

GUIDANCE: Radio command

PROPULSION SYSTEM: One General Electric J-85-5 Turbojet engine with 2,450 lbs. thrust

SUPPORT EQUIPMENT: Launched from a carrier aircraft

REMARKS: Improved version of the Q-4A which used a Fairchild J-83 Turbojet engine; also being used by the Navy

Redhead-Roadrunner (Army)

MILITARY DESIGNATION: MQM-42A

MISSION: Supersonic target missile

STATUS: Development

PRIME CONTRACTOR: Columbus Div., North American Aviation, Inc.

PERFORMANCE: Max. speed—Mach 2; service ceiling—over 60,000 ft.

CONFIGURATION: Span—72 in.; length—228 in.; diameter (body)—12 in.; weight—427 lbs.

GUIDANCE: System contractor—NAA; type—radio command

PROPULSION SYSTEM: Booster: one 6,000-lb.-thrust Rocketdyne solid motor; sustainer: one Marquardt ramjet engine

SUPPORT EQUIPMENT: Parachute-recoverable

REMARKS: Designed for both low- and high-level missions; for low-level flights, the drone will be flown without the wings

MQM-57A, Surveillance Drone (Army)

MISSION: Tactical battlefield surveillance drone capable of performing remote-controlled photo and other sensory missions

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max. speed—160 mph; stalling speed—95 mph; rate of climb—1,500 fpm; service ceiling—15,000 ft.; endurance—35 min.

CONFIGURATION: Span—138.1 in.; length—160.9 in.; height—31.4 in.; empty wt.—354.0 lbs.; useful payload—88.0 lbs.; total wt.—442.0 lbs.

FLIGHT CONTROL: Modified C-2A proportional-type command control system

TRACKING SYSTEM: AN/DPN-62 beacon (passive reflector pods optional) and an AN/MPQ-29 ground tracking system. Night lights for visual tracking

PROPULSION SYSTEM: Modified, four-cylinder, horizontally opposed, two-cycle, air-cooled engine (fuel capacity 5.6 gal.)

PAYLOAD: 88 lbs. of photographic and other sensory equipment

SUPPORT EQUIPMENT: Zero-length launcher; single-stage 44-ft. extended skirt recovery parachute

REMARKS: Only operational surveillance drone in the Army inventory; also being used by British troops

MQM-58A

MISSION: Tactical battlefield surveillance

STATUS: Production

PRIME CONTRACTOR: Aerojet-General Corp.

PERFORMANCE: Max. speed—345 mph; endurance—45 min.

CONFIGURATION: Span—156 in.; length—192 in.; launch wt. (less boosters)—1,103 lbs.

GUIDANCE: System contractor—ITT; Type—radio command

PROPULSION SYSTEM: System Contractor—Lycoming; type—1 IMO-360BIB, 225-hp engine; drone also uses 2 JATO units for launch from its zero-length launcher

PAYLOAD: Photographic and other sensory equipment

SUPPORT EQUIPMENT: Launched from Army 2½-ton truck

REMARKS: A modified version of the MQM-58A, is capable of performing Chemical Corps missions

Rocket Powered Target Drone (Army/AF/Navy)

MILITARY DESIGNATION: AQM-38A

MISSION: Target for surface-to-air and air-to-air weapon systems tests and annual service practices

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Supersonic version: Max. speed—Mach 1.3; service ceiling—75,000 ft.; endurance—4 min. Subsonic version: Max. speed—Mach 0.9; ceiling—61,800 ft.; endurance—8 to 9 min.

CONFIGURATION: Span—60 in.; length—116 in.; height—18 in; Max. weight—301 lbs.

INSTRUMENTATION: Six data channels on the tracking aid RF link for scoring.

FLIGHT CONTROL: Automatic with command control override

PROPULSION SYSTEM: Solid-propellant rocket engine with twin thrust nozzles canted 15 degrees outboard in a horizontal plane

SUPPORT EQUIPMENT: Launched from a fighter-type aircraft; recovery by 3-ft. ribbon brake chute and 24-ft.-dia. main chute

REMARKS: Used extensively by the Army for annual service practices of Nike-Hercules and Hawk units

AQM-37A Target Drone

MISSION: Supersonic target drone designed for air-to-air and surface-to-air weapon system testing and training

STATUS: Development

PRIME CONTRACTOR: Beech Aircraft Corp.

PERFORMANCE: Max. speed—Mach 2; service ceiling—70,000 ft.

CONFIGURATION: Span—39 in.; length—161 in.; diameter (body)—13 in.; weight—560 lbs.; frame—swept delta wings with canard controls

CONTROL SYSTEM: Two-axis autopilot

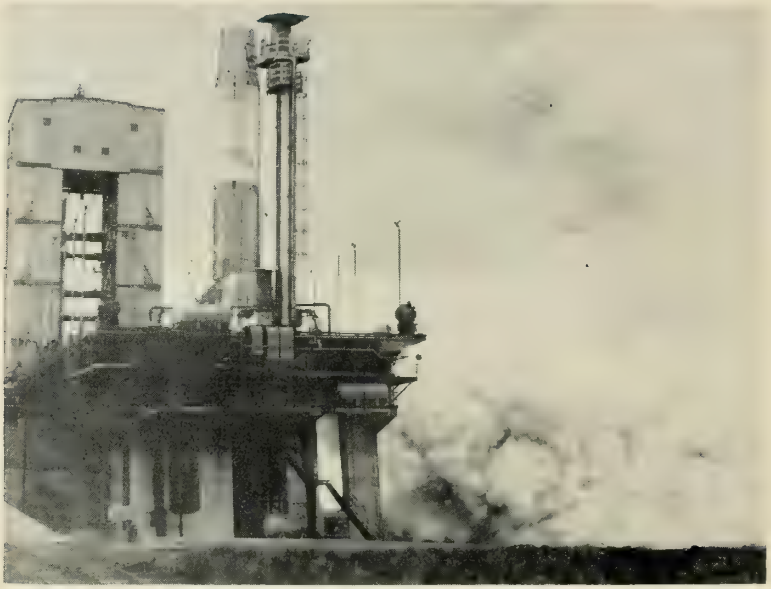
PROPULSION SYSTEM: One Rocketdyne liquid-propellant engine with 630 lbs. thrust

SUPPORT EQUIPMENT: Recoverable

REMARKS: Used by Air Force, Navy

Foreign

EUROPE



BLUE STREAK

Blue Streak (space booster)

STATUS: Development

PRIME CONTRACTOR: Hawker Siddeley Dynamics, United Kingdom

CONFIGURATION: Length, 61 ft. 6.3 in.; lift-off weight 207,579 lbs. with propellants assuming 193,892 lbs. 245 I_{sp} at liftoff developing 150,000 lbs. thrust. When empty, shell pressurization required at 5 lbs./sq. in.

PROPULSION: Twin Rolls-Royce LOX/K engines, designated RZ.12, developing combined thrust of 300,000 lbs.

REMARKS: First stage of European Launcher Development Organization space rocket

ELDO 2nd stage (space booster)

STATUS: R&D

TECHNICAL ADMINISTRATION: Délégation Ministérielle pour l'Armement, France

PERFORMANCE: Design goal: 61,600 lbs. total thrust to support options of first ELDO program.

CONFIGURATION: Four nozzles; length, 20.91 ft.; diameter, 6.89 ft.; all-up weight, 11.5 tons

PROPELLANTS: Specifications call for nitrogen tetroxide—N_2O_4 (peroxyde d'azote) and unsymmetrical di-methyl hydrazine

REMARKS: Flight tests scheduled for 1965

Europe's Space Plans

by Bernard W. Poirier

Contributing Editor

FOR THE FIRST time, MISSILES AND ROCKETS here lists the multilateral space effort in Europe under a separate heading in the Annual World Missile/Space Encyclopedia. More than $200 million has already been committed to the burgeoning cooperative endeavor outlined below:

Plan One

Program Sponsor: European Launcher Development Organization (ELDO)

Mission Options: 1) One-ton payload in 250-mi. circular orbit; 2) 220-lb. payload in elliptical polar orbit with 99,360-mi. apogee; 3) 44-lb. payload in high circular equatorial orbit for communications

Responsibilities: Plan has initial authorized budget of $200 million for first five years, with these allotments of funding and supply: AUSTRALIA (no funds), use of existing facilities substitutes for budget contribution; BELGIUM 2.85%, instrumentation of intermediate ground control stations; FRANCE 23.93%, rocket second stage; GREAT BRITAIN 38.78%, rocket first stage (*Blue Streak*); ITALY 9.78%, initial experimental satellite series including instrumentation; NETHERLANDS 2.64%, ground support equipment and third-stage telemetry; WEST GERMANY 22.02%, rocket third stage

Plan Two

Program Sponsor: ELDO

Two-year basic research into state of the art. Authorized budget of $5.6 million

Plan Three

Program Sponsor: ELDO

Currently known as Future Projects. Go-ahead probably to be decided in 1965-66. Optimism that CECLES/ELDO momentum will continue is reflected by private investment by Boelkow in OPHOS development (see *OPHOS IE* under Germany) and by France's second-generation ELDO R&D in H_2-O_2 propulsion

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European Space Research Organization (ESRO) is sponsoring interchange of research activity and information between more than a dozen nations. Final details of programs are still to be worked out. A tentative first step would be participation in the International Quiet Sun Year by Ionosphären Institut, Breisach, Germany, with two sounding rocket firings in 1964

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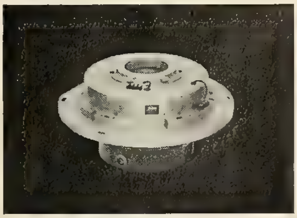

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Erno (booster stage)

TYPE: ELDO satellite booster third stage

STATUS: Design and development

PRIME CONTRACTOR: Entwicklungsring Nord and Boelkow-Entwicklungen KG, West Germany (jointly known as ASAT)

MISSION: Low orbit, 220-lb. payload option

CONFIGURATION: Launch weight, 9,900 lbs.; empty weight, about 1,100 lbs.; thrust, 2,250 + 2 × 50 kp; volume, 2,670 dm^3

GUIDANCE: Radio-inertial, two vernier rockets

TELEMETRY: Will carry onboard equipment

SIZE: Diameter 6½ ft., length, 12½ ft.

PROPULSION: Hypergolic; aerozine and N_2O_4; Main engine, 2.25 tons; vernier 50 kp and 30 kp

REMARKS: ASAT (Arbeitsgemeinschaft Satellitentrager) is German Satellite Carrier Advisory Group responsible for third-stage development work for the ELDO program. Total ASAT development cost estimated at $24 million

Ophos IE (booster stage)

TYPE: Proposed advanced ELDO third stage

STATUS: Research and Development

PRIME CONTRACTOR: Boelkow-Entwicklungen KG, West Germany

PERFORMANCE: Payload, 1,320 lbs.

CONFIGURATION: Gross design weight, 8,600 lbs.; empty, 1,150 lbs.; radial thrust chamber and E-D nozzle designed for 4,000 kp thrust; two verniers at 40 kp thrust in vaccum. High-energy propellants foreseen; O_2/H_2 and F_2/H_2 with emphasis on the latter

REMARKS: Mainly company-financed research with moderate government research funds from High Energy Rocket Engine National Development Project. Tests using LOX and subcooled H_2 already conducted

Australia

HAD (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment, Salisbury

PERFORMANCE: 3,200 mph at second-stage burnout; 20-lb. payload to 80 mi.

CONFIGURATION: Two-stage solid; length, 19½ ft.; second-stage diameter 5 in.; launch weight, 640 lbs.; weight of second stage, 115 lbs.

CODE MEANING: HAD=High-Altitude Density

HAT (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment, Salisbury

PERFORMANCE: Carries 20-lb. payload to 40 mi.

CONFIGURATION: Length, 17½ ft.; second-stage diameter, 5 in., launch weight, 540 lbs., second-stage weight, 115 lbs.

CODE MEANING: HAT=High-Altitude Testing

REMARKS: Developed for use in development of a drop sonde

Ikara (antisubmarine)

STATUS: R&D

PRIME CONTRACTOR: Weapons Research Establishment

REMARKS: No data released beyond fact it may be a torpedo carrier. Australian sources claim U.S. has invested $4 million in research

Jabiru (research rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment in Australia jointly with Royal Aircraft Establishment in U.K.

CONFIGURATION: Length, 39 ft.; three-stage solid; first-stage diameter, 1.43 ft.; span, 6.33 ft.; launch weight, 3,700 lbs.

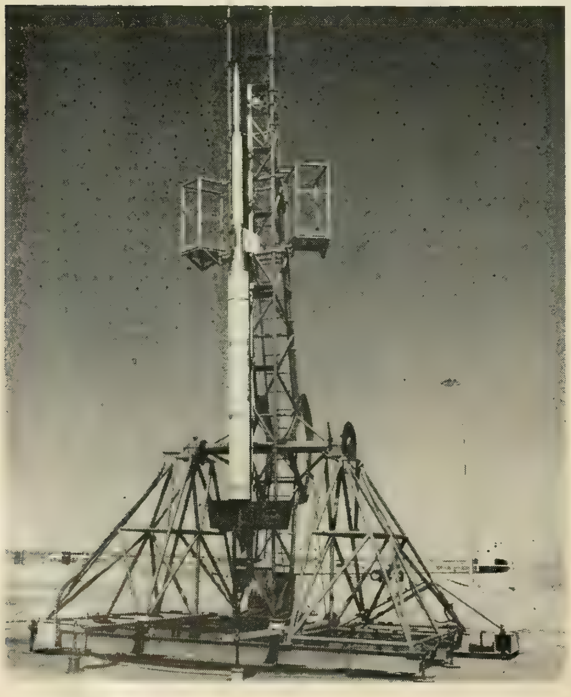
GUIDANCE: None

PAYLOAD: 55-lb. instrumentation head

PERFORMANCE: 6,400 mph at third-stage burnout; up to Mach 10 in level flight between 80,000 and 100,000 ft.

REMARKS: Known in U.K. as Jaguar

HAD SOUNDING ROCKET



HAT SOUNDING ROCKET

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RM

Long Tom (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment, Salisbury

PERFORMANCE: 30-lb. payload to over 100 mi. or 180-lb. payload to 68 mi.; 3,500 mph at second-stage burnout

CONFIGURATION: Two-stage solid; first stage cluster of three rockets; second-stage diameter 9.2 in.; launch weight, 2,000 lbs.; length, 27 ft.

REMARKS: Woomera Rocket Range instrumentation test vehicle for ground and airborne instrumentation. Evolved into "workhorse" capability; also used to measure micrometeorite prevalence and for high-altitude photography

Malkara (antitank)

STATUS: Operational

PRIME CONTRACTOR: Government Aircraft Factories (Australia)

PERFORMANCE: Range, 2 mi.; has received extensive anti-bunker and jungle evaluation

CONFIGURATION: Length, 6½ ft.; weight, about 200 lbs., span, 2 ft. 8 in.

GUIDANCE: Wire

EUROPEAN AGENT: British Aircraft Corporation handles European export sales

PROPULSION: Two-stage solid

Canada

Alouette (satellite)

STATUS: In orbit

PRIME CONTRACTOR: Canadian Defense Research Telecommunications Establishment

PERFORMANCE: Successful ionospheric data transmissions since orbiting Sept. 28, 1962, by Thor-Agena B from Point Arguello, Calif.

CONFIGURATION: Nearly oval; 42-in. diameter; 320 lbs.; 6,500 solar cells; one 150-ft. antenna; one 75-ft. antenna

REMARKS: First non-Soviet, non-U.S. satellite in space. All-Canadian fabrication. Modified Alouette is expected to be orbited next year as part of NASA's continuing joint international program with Canada

Black Brant (sounding rockets)

STATUS: Mk 2 and Mk 3 operational; Mk 4 and Mk 5 in R&D; Mk 1 developed by CARDE

PRIME CONTRACTOR: Mk 1, Canadian Armament Research and Development Establishment; Mk 2 Canadair, Ltd (Montreal) and Canadian Bristol Aerojet Ltd, (Winnipeg); Mk 3, 4 and 5 by Bristol Aerojet Ltd. (Winnipeg)

PERFORMANCE: Mk. 2; 150 lbs. to 125 mi.; Mk 4, 40 lbs. to 600 mi.; Mk 5, 150 lbs. to 240 mi.

CHARACTERISTICS: Mk 4 two stages, others one stage; all solid-fuel using polyurethane/ammonium perchlorate (developed by CARDE)

FLIGHTS: Mk 2 launched from Wallops Island and Fort Churchill; Mk 3 from Wallops Island and Point Mugu

REMARKS: Example of Canadian national research in space project eventually made available to industry; such as suggested in Isis program

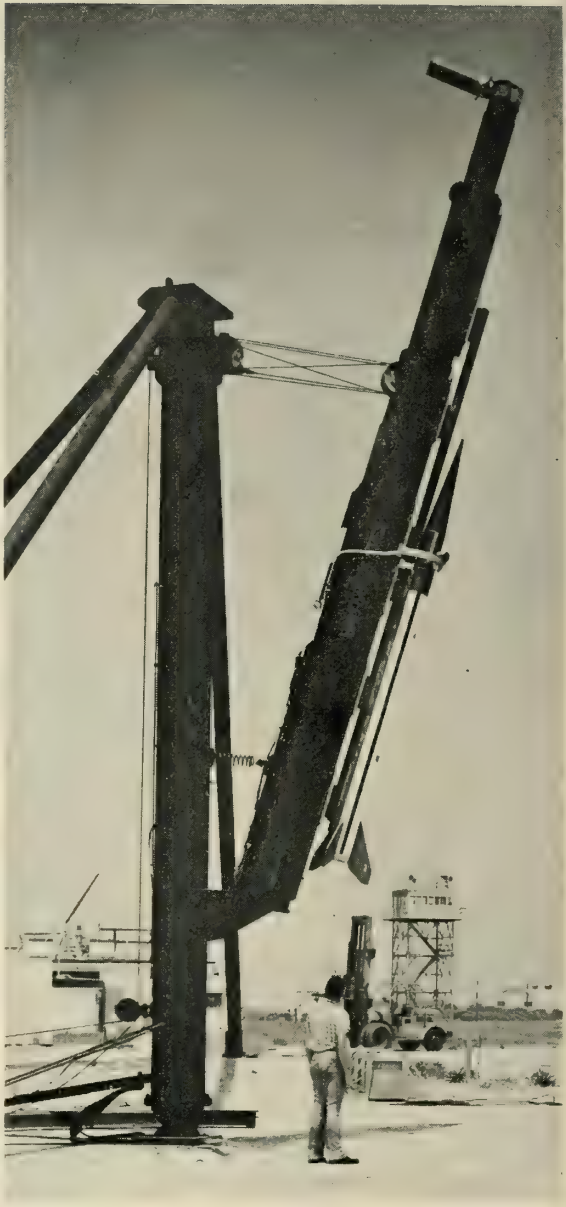
Isis (satellite)

STATUS: Design

PRIME CONTRACTOR: To be designated or selected

PERFORMANCE: Not announced. Plans call for three satellites in Isis program

REMARKS: Canadian industry expected to be invited to participate in program to allow industry to acquire techniques developed by Canadian laboratories



BLACK BRANT

Egypt

Al Kaher (Conqueror) (missile)

TYPE: Surface-to-surface

STATUS: Development

PERFORMANCE: Range, 372.6 mi.

CONFIGURATION: Single-stage, liquid-fuel

REMARKS: Twenty missiles in July 23, 1962, parade in Cairo. First public announcement of launching made on July 21, 1962

Al Zafer (Victorious) (missile)

TYPE: Surface-to-surface

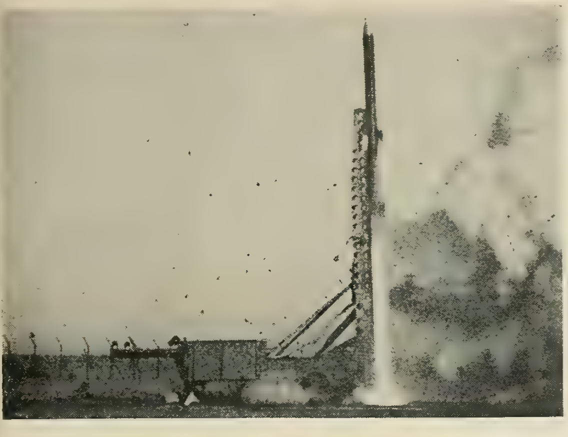
STATUS: Development

PERFORMANCE: Range, 235.9 mi.

CONFIGRATION: Single-stage, liquid-fuel

REMARKS: First public test launching July 21, 1962

France



CENTAURE

Agate (rocket)

TYPE: IRBM research rocket

STATUS: Operational

PRIME CONTRACTOR: SEREB (Société pour l'Etude et la Réalisation d'Engins Balistiques) and Sud-Aviation, Groupe Technique de Cannes

PERFORMANCE: Has reached 30-mi. altitude with half-ton payload

CONFIGURATION: Length, 27.8 ft.; single stage; all-up weight, over 3 tons

GUIDANCE: None

REMARKS: SEREB, technical IRBM agency under Délégation Ministérielle de l'Armement, is composed of representation of Sud-Aviation, Nord Aviation, ONERA, Dassault, SNECMA, Matra and SEPR; in Precious Stones Series; others in series, Diamant, Emeraude, Rubis, Saphir and Topaze

AS-20 (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

CONFIGURATION: Length, 8.5 ft.; diameter, 9.84 in.; span, 2.5 ft.; weight, 293 lbs. Solid booster and sustainer

GUIDANCE: Radio control, visual alignment

AS-30 (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

CONFIGURATION: Length, 12.5 ft.; diameter, 13.5 in.; span, 3.3 ft.; weight, 1,100 lbs. Solid booster and sustainer

GUIDANCE: Multi-channel HF transmitter

Bélier (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: 4,070 lbs. thrust 22 sec.; spec. imp. 203 sec.; max. alt., 50 miles; max. vel. 4,330 ft./sec. Typical payload, 66 lbs.

CONFIGURATION: Single solid booster. Jericho "epictete" propellant grain (457 lbs.). Length, 13.1 ft.; all-up weight, 689 lbs. Fins house telemetry gear and responder antennas

INSTRUMENTATION: CNET

Bérénice (rocket)

TYPE: IRBM Research

STATUS: Operational

PRIME CONTRACTOR: Office National d'Etudes et de Recherches Aérospatiales (ONERA) for SEREB (IRBM Agency)

PERFORMANCE: Mach 12 re-entry when 3rd and 4th stages fired in descent

CONFIGURATION: Four solid stages. Length, 42 ft.; diameter: 1st stage, 22 in., 4th stage, 9 in.; all-up weight, 7,400 lbs.

GUIDANCE: First stage has three axis autopilot transmitting command signals to four solid boosters attached to first stage. Attitudes of 3rd and 4th stages controlled before re-entry

INSTRUMENTATION: ONERA telemetering equipment

PROPULSION: Four solid stages and four small "guidance" solid rockets. All but 4th stage by SEPR

REMARKS: Optical ground equipment of the French Navy Launching Center (CERES) on Levant Island in Mediterranean. Also, ONERA and CERES electromagnetic trojectography

Centaure (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 1st stage, 8,800 lbs. 4 sec.; 2nd stage, 4,070 lbs. 22 sec.; spec. imp.: 1st, 200; 2nd, 203; typical payloads, 100 lbs. with max. alt., 91.9 miles; max. vel., 5,834 ft./sec.

CONFIGURATION: Length, 19.5 ft. Diameter: 1st, 9.8 in.; 2nd, 11 in.; all-up weight, 1,080 lbs. max. Two solid stages, first-stage propellant grain is 206.8 lbs. Venus "Plastolite." Second stage is modified Bélier

REMARKS: First-stage diameter smaller than second stage. Used in Argentina tests last year as part of COSPAR Synoptic Rocket Soundings Program

Dauphin (sounding rocket)

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Max. altitude, (220-lb. payload) 85 mi., (650-lb. payload) 50 mi.

CONFIGURATION: Single solid stage; length, 16.7 ft.; diameter, 2.8 ft.

Diamant (space rocket)

STATUS: Development

PRIME CONTRACTOR: Centre National d'Etudes Spatiales and Délégation Ministérielle de l'Armement

TECHNICAL ADMINISTRATION: SEREB

CHARACTERISTICS: Mk 1: Liquid first stage, 32.8 ft. in length has all-up weight of 31,240 lbs. with total thrust of 28 tons. Spent weight, 3,740 lbs. Second stage: Modified *Topaze* (See *Topaze* details). Third stage: Glass fiber-wound Sud-Aviation design. Solid fuel. 26 in., 1,430-lb. polyurethane grain burns 47 sec.

REMARKS: Mk 2 version may have 45.9-in. diameter solid-grain first-stage motor developing up to 40 tons, compared to Mk 1 first-stage thrust of 28 tons. Service des Poudres has already developed and tested grains weighing 25 tons. First satellite attempt scheduled for early 1965. In Precious Stones series

Dragon (sounding rocket)

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 1st stage, 24,000 lbs. 16.5 sec.; 2nd., 4,070 lbs. 22 sec.

CONFIGURATION: Length, 23 ft.; diameter, 1st 2.8 ft.; 2nd 11 in.; weight, 2,926 lbs.

INSTRUMENTATION: CNET

PROPELLANT: La Pouderie de St.-Médard

ENTAC (missile)

TYPE: Antitank

REMARKS: Prime contractor DEFA; first-line European producer, Atelier de construction de Puteau; producer for U.S. Army, Nord Aviation. See U.S. surface-to-surface missiles

Emeraude (space rocket)

STATUS: R&D

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: Liquid first stage, dummy second and third stage. Will test Diamant first-stage propulsion plus design and airframe structure for Diamant

REMARKS: In Precious Stones series

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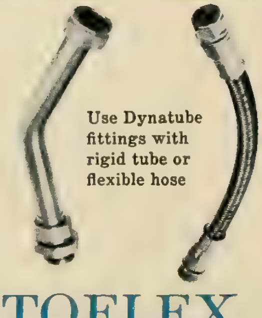

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Eridan (sounding rocket)

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust, each stage 22,000 lbs. for 15 sec.

CONFIGURATION: Two solid stages. Length, 27.2 ft.; weight, 4,466 lbs.

FR-1 (satellite)

STATUS: R&D

PROGRAM SPONSOR: Centre National d'Etudes Spatiales (CNES)

TECHNICAL ADMINISTRATION: Centre National d'Etudes des Télécommunications (CNET)

PRIME CONTRACTOR: Nord Aviation

CONFIGURATION: Design specifications indicate weight about 110 lbs.

TELEMETRY: CNES

INSTRUMENTATION: CNET

INTEGRATION: CNES

LAUNCH RESPONSIBILITY: Office of International Programs, NASA

MISSION: VLF measurements

REMARKS: STL selected to assist FR-1 project. Some French systems will be flight-tested from Wallops Island in late 1963. Orbiting foreseen between late 1964 and early 1965. U. S. expected to provide solar cells subsystem

Geneviève (satellite)

STATUS: R&D

PRIME CONTRACTOR: SNECMA (Société Nationale d'Etude et de Construction de Moteurs d'Aviation)

REMARKS: France's first telecommunications satellite proposed for synchronous orbit in TV relay system using nuclear power source. SNECMA proposes electro-thermal arc for propulsion in first phase and instrumentation power in subsequent phases

Latécoère 110 (rocket)

TYPE: Research Vehicle

STATUS: R&D

PRIME CONTRACTOR: Société Industrielle d'Aviation Latécoère

REMARKS: Postal experimental vehicle developed for Ministry of Mail and Telecommunications (Postes et Télécommunications)

Masurca (missile)

TYPE: Ship-to-air

STATUS: Development

PERFORMANCE: Mk 2 Mod 2: 20 mi.; Mk 2 Mod 3: 25 mi. Velocity: Over 2,500 ft./sec.

CONFIGURATION: Two stages. Length, 27.9 ft.; weight, 3,828 lbs. Solid booster and sustainer

GUIDANCE: Mk 2 Mod 2: Beam rider. Mk 2 Mod 3: Beam rider and semiactive homing

RADAR/RADIO CONTROL: Société Française Thomson-Houston

FIRE CONTROL: I.B.M. France

TECHNICAL ADMINISTRATION: Service Technique des Constructions et Armes Navales

LAUNCHING AND HANDLING: Etablissement Industriel de la Marine Nationale à Ruelle

REMARKS: Mk 1 in production and destined for early available missile frigates. Mk 2 will arm Duquesne and Suffren class frigates, helicopter carrier La Résolue and future frigates

Malafon (missile)

TYPE: ASW

STATUS: Operational

MISSILE PRIME CONTRACTOR: Société Latécoère

PERFORMANCE: Range, over 14,000 yds. Velocity, 754.4 ft./sec.

CONFIGURATION: Twin solid boosters. Carries ASW homing torpedo. Overall length, 19.7 ft.; all-up weight, 3,179 lbs.

GUIDANCE: Radio control

TECHNICAL ADMINISTRATION: Service Technique des Constructions et Armes Navales

REMARKS: First sea tests in 1962. Will arm frigates now under construction and on T.47 class escort vessel

Matra R. 530 (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Société des Engins MATRA

PERFORMANCE: For use on latest French fighter/attack aircraft

CONFIGURATION: Length, 11 ft.; diameter, 10 in.; weight, 429 lbs.

GUIDANCE: Version A: Semiactive radar homing system by G. A. M. Dassault. Version B: Infrared homing by Société Anonyme de Télécommunications

OTHER SYSTEM SUBCONTRACTORS: Hotchkiss-Brandt, Compagnie Générale de Télégraphie Sans Fil, and Télécommunications Radio-électriques et Téléphoniques

REMARKS: Witnesses to flight tests described R. 530 as "Queen" of air-launched missile armament. Trials reported highly successful

Matra R. 511 (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Société des Engins MATRA

CONFIGURATION: Length, 10.14 ft.; diameter, 10 in.; weight, 396 lbs.

GUIDANCE: Compagnie Française Thomson-Houston system

PROPULSION: Solid fuel by Hotchkiss-Brandt

Phaeton (satellite)

STATUS: R&D

PRIME CONTRACTOR: SEPR

PERFORMANCE: Design goal: Thermic-electrical propulsion: 20 to 40 grams

CONFIGURATION: Length from boiler (top) to reservoir tank (bottom), 16.4 ft.; diameter of parabolic reflector, 15.7 ft.; all-up weight options vary from 660 lbs. to 2,420 lbs. Auxiliary power 2.25 kw. Orbiting propulsion system would utilize liquid hydrogen reaching 3000°k. Payload instrumentation and fuel required for mission provide tradeoff parameters for available 250 lbs.

PROGRAM SPONSOR: CNET

REMARKS: Mission proposal not yet adopted by CNES

Saphir (space rocket)

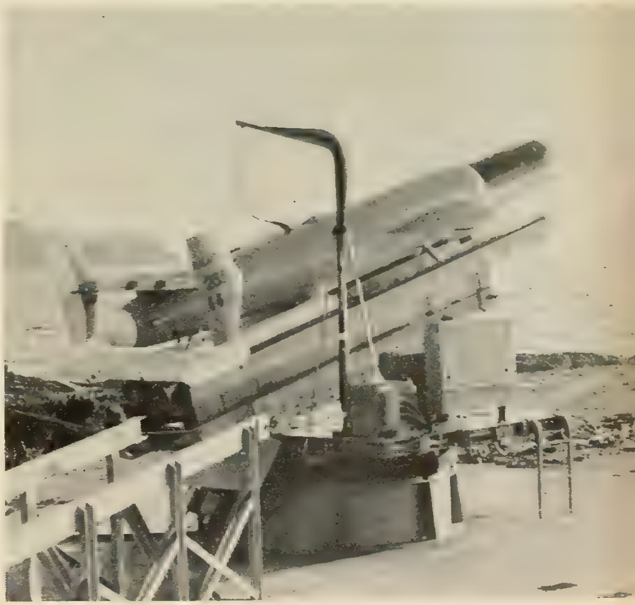
STATUS: R&D

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: Liquid first stage; solid second stage; dummy third stage. Follows Emeraude in proving Diamant design

GUIDANCE: Probably modified Topaze system

REMARKS: In Precious Stones series



MALAFON

STATALTEX

Rubis (space rocket)

STATUS: R&D

REMARKS: In Precious Stones series

SS-10 (missile)

TYPE: Antitank

REMARKS: See U. S. surface-to-surface missiles

SS-11 (missile)

TYPE: Antitank

REMARKS: See U. S. Surface-to-surface missiles

SS-12; AS-12 (missile)

TYPE: SS, Antitank; AS, Air-to-surface

STATUS: R&D, evaluation

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Surface launch, max. range, 6,550 yds.; air launch, max. range, 11,000 yds.; spin-stabilized

CONFIGURATION: Length, 63 in.; diameter, 7.1 in.; 165 lbs.

Stataltex (rocket)

TYPE: Experimental vehicle

STATUS: Operational

PRIME CONTRACTOR: ONERA

PERFORMANCE: Mach 5 plus in early 1961 trials. Sees continuous use for ram-jet propulsion tests. Reaches 125,000 ft. at lower Mach number. Booster gives Mach 3.2, sustainer ignites at 23,000 ft.

CONFIGURATION: Length, 17 ft.; max. diameter, 16½ in.

GUIDANCE: None, but carries ONERA telemetering instrumentation

PROPULSION: Ramjet sustainer. Solid SEPR booster

SUPPORT EQUIPMENT: French Navy range optical units at CERES Missile Range off Riviera coast on Levant Island

REMARKS: ONERA and Nord Aviation have agreement for cooperation in ram-jet development field

Topaze (rocket)

TYPE: IRBM research vehicle and Diamant second-stage prototype

STATUS: Flight testing

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: First stage: Nord-designed rocket plant using four SEPR motors and power pack by Air-Equipement. This stage constitutes booster. Second stage: Nord-designed rocket plant. 30-in. polyurethane grain weighs 5,005 lbs.; burns 42 sec.; up to 30,000 lbs. thrust in vacuum. Flight control by swivel nozzles. Autopilot guidance by S.A.G.E.M. Interstage and equipment section by Sud Aviation SEFI automatic check-out system

REMARKS: Diamant will use modified Topaze as second stage. Prototype Diamant third stage was given compatibility flight test with Topaze and recovered by parachute in test at Hammaguir. Propellant grain manufactured by La Pouderie de St.-Médard. In Precious Stones series

Vega (rocket)

STATUS: Experimental vehicle

PRIME CONTRACTOR: Nord Aviation. Special arrangement with ONERA (See Stataltex.)

PERFORMANCE: Has reached Mach 4. Operating altitude, 65-110,000 ft.; solid booster, 5 sec.; Booster, Mach 2

CONFIGURATION: Length, 32.5 ft.; diameter of booster, 22 in., sustainer, 26 in. Ramjet second stage

GUIDANCE: Autopilot

PROPULSION: Booster, Vesuve-type solid propellant

REMARKS: Nord conducts lead ramjet R & D efforts for Direction Technique et Industrielle de l'Aéronautique

Vesta (sounding rocket)

STATUS: R&D flight tests (1963 O.A.D.)

PRIME CONTRACTOR: D.E.F.A., Laboratoire de Recherches Balistiques et Aérodynamiques (Vernon)

PERFORMANCE: 1,100-lb. payload to 236 mi. Five times early Véronique payload area

CONFIGURATION: Length, 32.5 ft.; diameter, 32.8 in.; all-up weight, 11,979 lbs.; total surface thrust, 31,680 lbs.; I_{sp} at surface, 193, in vacuum, 238

REMARKS: Vesta is higher performer than Véronique 61 or 61A

X Series* (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

MISSION: First all-French satellite to be orbited by Diamant rocket. Launch schedule early 1965

CONFIGURATION: 176 lbs. design specifications

* M/R designation; no official name

Y Series* (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

TECHNICAL ADMINISTRATOR: Centre d'Enseignement et de Recherches Médicales Aéronautiques

MISSION: Mk 1: Capsule carrying cat in suborbital flight, 1963. Mk 2: Capsule carrying monkey using Diamant booster, 1964/65; might be delayed for orbital trajectory

REMARKS: Follow-on bioscientific program directed by CERMA. Highlight was February, 1961, experiment with "Hector the Rat." Delicate brain operation was involved. Associated organizations were CNET and Sud Aviation (M/R, May 22, 1961, p. 42.)

* M/R designation; no official name

Z Series* (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

MISSIONS: 1) Modified satellite with advanced radiation-measurement instrumentation and telemetry for powered booster performance and attitude; 2) Advanced J. E. Blamont instrumentation; hydrogen measurements; 3) Magnetic and laser experiments; 4) Solar-oriented experiments

REMARKS: Program definitizations expected before end of year in Major Defense/Science announcement

* M/R designation; no official name

Life support for 14 days in space

The NASA-McDonnell Project Gemini is the major link between Project Mercury and Project Apollo (this nation's first flight to the moon). It will give our space effort vital information on prolonged spaceflight effects and will also be used to test space rendezvous techniques.

Gemini's advanced environmental system will keep the spacecraft's two astronauts comfortable for two weeks of continuous orbital flight. Garrett-AiResearch builds the system that provides a breathable atmosphere, pressurization, temperature control, ventilation and atmosphere purification in the two-man spacecraft and in both astronauts' suits for the entire flight. AiResearch also supplies the supercritical cryogenic oxygen and hydrogen tankage system for the fuel cell power supply.

This major contribution to the advancement of space travel is one more example of Garrett's proved capability in the design and production of vital systems and their components for man's most challenging exploration.

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Environics, new space age concept from AAF,

is the art of total-system environment control—developed, produced and installed through a single corporate source and engineer-management team. For example, the integral automatic system making each Minuteman missile and launch-control center environmentally self-supporting.

AAF Environics is not synonymous with air conditioning: examples include ultra-high reliability features, shock-proof configurations, radio-interference suppression, filtering efficiency, and explosion-proof operation features beyond any conventional air-conditioning or air-handling equipment. In fact, no conventional limitations apply to Environics.

Reliable AAF Defense Group teams move quickly to the heart of any environmental-control problem. They develop all required designs, prototypes, tests, and test facilities. They draw on six AAF manufacturing divisions to fill all needs on schedule and without compromise. They provide and supervise installation in the field, with complete responsibility for hardware deliveries, checkout, operation, and maintenance of the system.

AAF Environics is founded on a unique range of products and experience . . . nearly four decades of pioneering in all phases of environment control, civilian and military. Ask for AAF Bulletin D-164A and assistance on your Weapons or Command system problem. *Defense Products Group, American Air Filter Co., Inc., 1270 N. Price Road, St. Louis 32, Missouri.*

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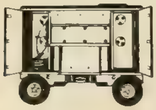

Environmentally self-supporting checkout assembly developed for B-58 Fire Control. AAF filtered conditioned air and trailer with shock-dampened carriage. Model C-10 Electronic Test Trailer.

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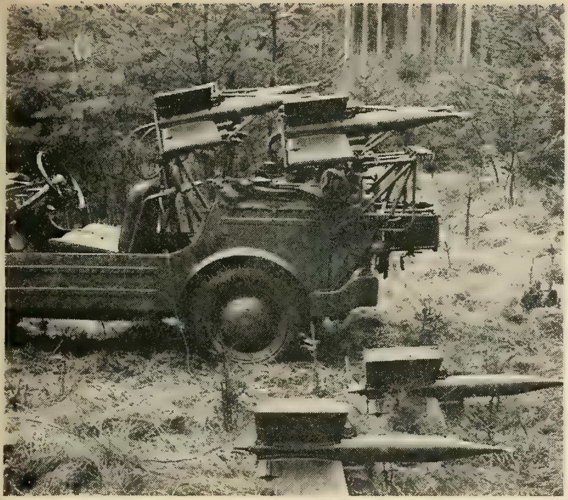

COBRA

Germany

Cobra 810 (missile)

TYPE: Antitank

STATUS: Operational with West German Army; Denmark and Italy have ordered

PRIME CONTRACTOR: Boelkow-Entwicklungen KG

PERFORMANCE: Range, 437 to 1,750 yds. at about 190 mph

CONFIGURATION: Length, 38 in.; span, 3.9 in.; launch weight 23.3 lbs.

GUIDANCE: Wire-guided, rolling stability acceleration guidance

REMARKS: Top feature: ease of one-man handling

Dornier 'X' (sounding rocket)

STATUS: Evaluation

PRIME CONTRACTOR: Dornier-Werke G.m.b.H.

PERFORMANCE: 11-lb. payload to 54-mi. altitude. Cited as "recoverable"

CONFIGURATION: Rogallo wings

REMARKS: Winged vehicles flown by Tilling at Tempelhof Airport, Berlin, on Nov. 13, 1932. Dornier Rogallo wings are innovation in sounding rockets

Great Britain

Bloodhound (missile)

TYPE: Surface-to-air

STATUS: Mk 1 operational with RAF; Mk 2 is R&D

PRIME CONTRACTOR: British Aircraft Corp. (BAC) with Ferranti Ltd.

PERFORMANCE: Mk 1, high-altitude, long-range; Mk 2, same with faster reaction and low-altitude capability

CONFIGURATION: Mk 1, four solid boosters with two ramjet sustainers

GUIDANCE: Radar-guided with terminal homing

OTHER CONTRACTORS: Supporting BAC and Ferranti are Associated Electrical Industries Limited, Bristol Siddeley Engines Limited, Electrical and Musical Industries Limited, and M.L. Aviation Limited

REMARKS: Mk 1 operational units in U.K., Sweden and Australia. Switzerland has adopted Mk 2 system for air defense

Blue Steel (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Hawker Siddeley Dynamics (A. V. Roe & Company Ltd.)

CONFIGURATION: Length, 35 ft.; max. diameter 4 ft. 2¼ in.; span, 13 ft.

GUIDANCE: Autopilot and inertial navigator. Elliott Bros. Ltd.

PROPULSION: H.T.P. and Kerosene Stentor engine by Bristol Siddeley Engines Ltd.

REMARKS: Operational on Vulcan and Victor bombers

CF.299 (missile)

TYPE: Ship-to-air

STATUS: R&D

PRIME CONTRACTOR: Hawker Siddeley Dynamics (Whitworth Gloster Aircraft Ltd.)

SUBCONTRACTORS: Associated Electrical Industries Ltd., EMI Electronics Ltd., Ferranti Ltd., G.E.C. (Electronics) Limited, Sperry Gyroscope Company Limited, Vickers-Armstrongs (Engineers) Ltd.

REMARKS: Intended for use on small vessels. Would provide frigates with firepower comparable to 5,000-ton guided missile ships now in service

Jaguar (rocket)

TYPE: Research

STATUS: Operational

PRIME CONTRACTOR: Royal Aircraft Establishment jointly with Weapons Research Establishment in Australia

REMARKS: For details, see Jabiru rocket, Australia section

Firestreak (missile)

TYPE: Air-to-air

STATUS: All-service use

PRIME CONTRACTOR: Hawker Siddeley Dynamics (de Havilland Aircraft Company Ltd.)

PERFORMANCE: 85% success in acceptance trials

GUIDANCE: Infrared-homing, radar-slaving

Red Top (missile)

TYPE: Air-to-air

STATUS: In acceptance trials

PRIME CONTRACTOR: Hawker Siddeley Dynamics (de Havilland Aircraft Company Ltd.)

PERFORMANCE: Better range, speed, altitude and attack angle than Firestreak

CONFIGURATION: Retains Firestreak design of four fixed wings and four moving rear control surfaces; also solid fuel

GUIDANCE: Infrared-homing, automatic firing upon pilot's committal release

REMARKS: Has printed circuit boards. Automatic soldering used in production

Seacat (missile)

TYPE: Ship-to-air

STATUS: Operational

PRIME CONTRACTOR: Short Brothers & Harland Ltd.

PERFORMANCE: Short-range ship's defense

CONFIGURATION: Length, 58 in.; solid-fuel tandem booster and sustainer

GUIDANCE: Radio command/optically coordinated

LAUNCHER: Rose Brothers

DEVELOPMENT: Mk 2 in R&D

REMARKS: $8 million in export orders on hand in March. New Zealand, West Germany, Australia and Sweden already ordered system, others interested. Dutch fire control by Signaalapparaten used with missile on Swedish ship Sodermanland. Venezuela has also exhibited interest in naval adaptation

Seaslug (missile)

TYPE: Ship-to-air

STATUS: Mk 1 Operational, Mk 2 R&D

PRIME CONTRACTOR: Hawker Siddeley Dynamics (Whitworth Gloster Aircraft Ltd.)

PERFORMANCE: Long-range ship's defense; Mk 1 on County-class guided missile ships

CONFIGURATION: Mk 1: Length, 19.8 ft.; span 4.8 ft. Four solid boosters and solid sustainer

GUIDANCE: Beam-riding, General Electric Co., Ltd.

FLIGHT CONTROLS: Sperry Gyroscope Co., Ltd.

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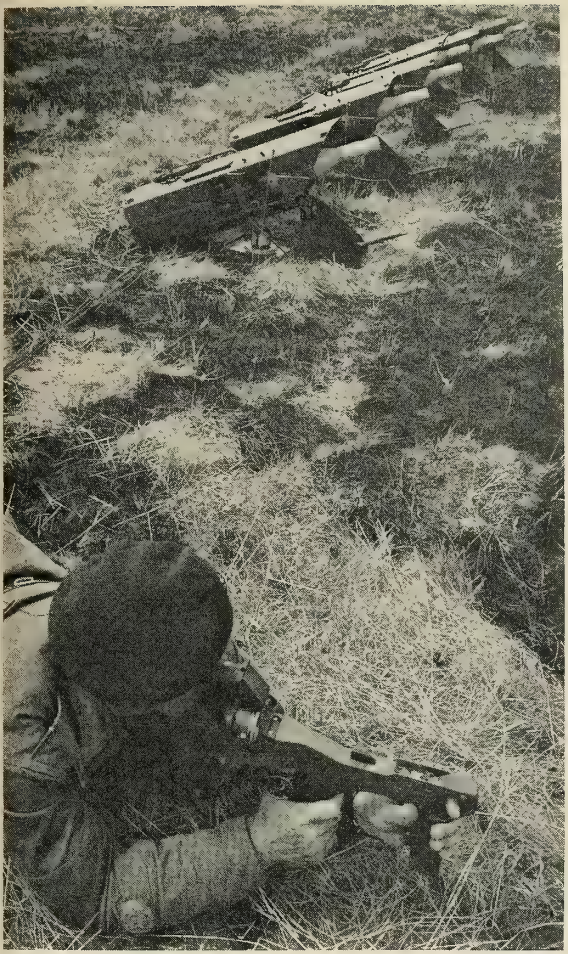


VIGILANT

Swingfire (missile)

TYPE: Antitank

STATUS: R&D

PRIME CONTRACTOR: British Aircraft Corporation

REMARKS: Described as second-generation antitank missile. BAC and Nord Aviation, leading antitank missile producer, have technical arrangement which possibly affects Swingfire development

Thunderbird (missile)

TYPE: Surface-to-air

STATUS: Mk 1, operational, Army; Mk 2, Development

PRIME CONTRACTOR: British Aircraft Corporation (English Electric)

GUIDANCE: Radar command

REMARKS: Mk 2 designed to be more automatic, have longer range; employs CW radar

UK 3 Series (satellite)

STATUS: Design

PRIME CONTRACTOR: British Aircraft Corporation

PERFORMANCE: No. 1 of series to have orbit altitude of 400 mi., circular with 57° inclination to the equator

CONFIGURATION: All-British fabrication including new aluminum shell design

ENVIRONMENT TEST PROGRAM: BAC, Stevenage and Space Dept., Royal Aircraft Establishment, Farnborough

COORDINATION OF EXPERIMENTS: Ministry of Science and the Royal Society

PROGRAM SPONSOR: Ministry of Aviation in cooperation with the Office of International Programs, NASA

REMARKS: UK 1 (Ariel) orbited by NASA in April, 1962. Participants in internal systems fabrication or design included University of London, University of Leicester, University of Birmingham, Imperial College. UK 2 to be orbited by NASA in 1963; UK 3 series expected to total five satellites.

Vigilant (missile)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: BAC (English Electric Aviation Ltd.)

PERFORMANCE: Range: 250 to 1,800 yds., penetrates 22-in. armor plate

CONFIGURATION: Total systems weighs less than 50 lbs.

GUIDANCE: Wire

REMARKS: Kuwait Army has Vigilant units

Israel

Shavit Shtayem (Meteor II) (rocket)

TYPE: Surface-to-surface

STATUS: Research vehicle

PERFORMANCE: Only public flight test reached 48-mi. altitude

Italy

Meteo I (sounding rocket)

STATUS: Experimental tests

PRIME CONTRACTOR: Bombrini Parodi-Delfino

PERFORMANCE: 12-lb. payload to 43 mi.

CONFIGURATION: Two stage. Overall length, about 8 ft.; Diameter, about 10 in. Solid fuel

REMARKS: Meteo II, 25-lb. payload to 62 mi.; Meteo III, 25-lb. payload to 95 mi.; max. diameter, Mk. III, 21 in.

Mosquito (missile)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Contraves Italiana

REMARKS: Joint production with Swiss Contraves (See details under Switzerland)

Japan

Mat I (missile)

TYPE: Antitank

STATUS: Development

PRIME CONTRACTOR: Kawasaki Aircraft Co. Ltd. (Gifu Seisakusho)

GUIDANCE: Wire

Lambda Series (sounding rockets)

STATUS: Flight-testing

PRIME CONTRACTOR: National Space Activities Council and Institute of Industrial Science, University of Tokyo

CONFIGURATION:	Lambda I	Lambda II	Lambda III	Lambda IV
Length	32.8 ft.	49.2 ft.	59.0 ft.	59.0 ft.
Weight	4.6 tons	5.7 tons	6.0 tons	6.0 tons
PERFORMANCE:				
Max. velocity ft./sec.	6,232	8,209.8	10,824	15,744
Max. altitude miles (80 deg.)	49.7	211.1	310.5	931.5
Payload (lbs.)	1,100	220	110	22

SUBCONTRACTORS: Radio Research Laboratories; Yokogawa Electric Co., Ltd.; Riken Institute; Nippon-Electric Co., Ltd.; Meisei-Electric Co., Ltd.; Fuji-Precision-Machinery Co., Ltd.

REMARKS: Lambda performance, particularly long horizontal range, required use of new rocket range at Kagoshima Space Center, Uchinoura

KAPPA 9L

Kappa 9L (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: C. Itoh & Co., Ltd.

TEST VEHICLE PERFORMANCE: 9,020 ft./sec. at 27.3 mi.; max. acceleration 32.3 g; max. re-entry deceleration –35 g.

TEST VEHICLE CONFIGURATION: Three solid stages. All-up weight: 3,446 lbs.; length, 42 ft. approx.

REMARKS: Kappa 9L developed as part of national sounding rocket program. Itoh spokesman at Paris Aerospace Show said price was $35,000 per copy

TERNE III

Norway

Terne III (missile)

TYPE: ASW

STATUS: Operational on Norwegian and U. S. ships

PRIME CONTRACTOR: Kongsberg Vapenfabrikk

PERFORMANCE: Short to medium range; firing sector 360°

CONFIGURATION: Length, 6.5 ft.; diameter, 7.9 in.

GUIDANCE: None

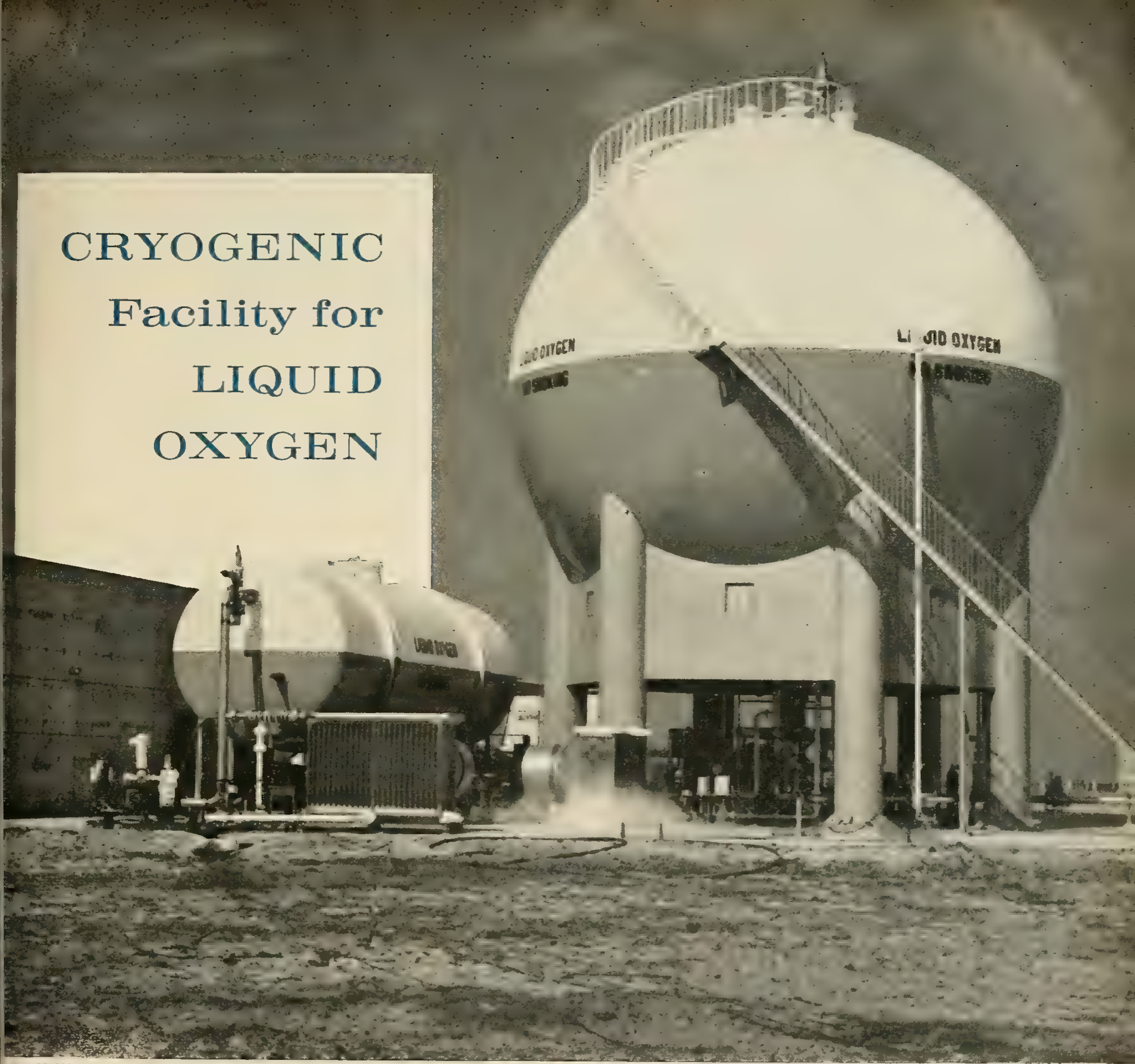
FIRE CONTROL: Sonar, computers and remote-controlled launcher

PROPULSION: Solid

PAYLOAD: Terne H.E. Missile Mk 7

REMARKS: Can fire a 6-missile salvo in 5 sec. Salvo reload time is 40 sec.

CRYOGENIC Facility for LIQUID OXYGEN



CB-621

41′3″ dia. sphere and 11′ dia. x 37′8″ blimp, for liquid oxygen storage.

...LO_2 for biggest booster at Cape Canaveral

The first-stage booster of the huge Saturn space vehicle has a thrust of 1,300,000 lbs. To store the liquid oxygen needed for this tremendous thrust, CB&I designed and built the cryogenic storage tanks and pressurization system shown above for the NASA Marshall Space Flight Center, at Cape Canaveral, Fla.

A 125,000 gallon field-erected sphere and a 13,000 gallon horizontal blimp are the key units. Both are double-walled, insulated vessels. The sphere keeps the liquid oxygen in readiness at −297°F for pumping directly to the firing pad. The blimp serves as a topping tank, operating under a pressure of 200 psi to maintain the fuel level in the booster until firing.

This installation is another example of CB&I's skills in designing and building cryogenic storage systems. As the world's most experienced builder of such facilities, CB&I can be of great help in planning the most efficient system for you. Write for Bulletin G-50. Chicago Bridge & Iron Company, 332 S. Michigan Ave., Chicago 4, Ill. Offices and subsidiaries throughout the world.

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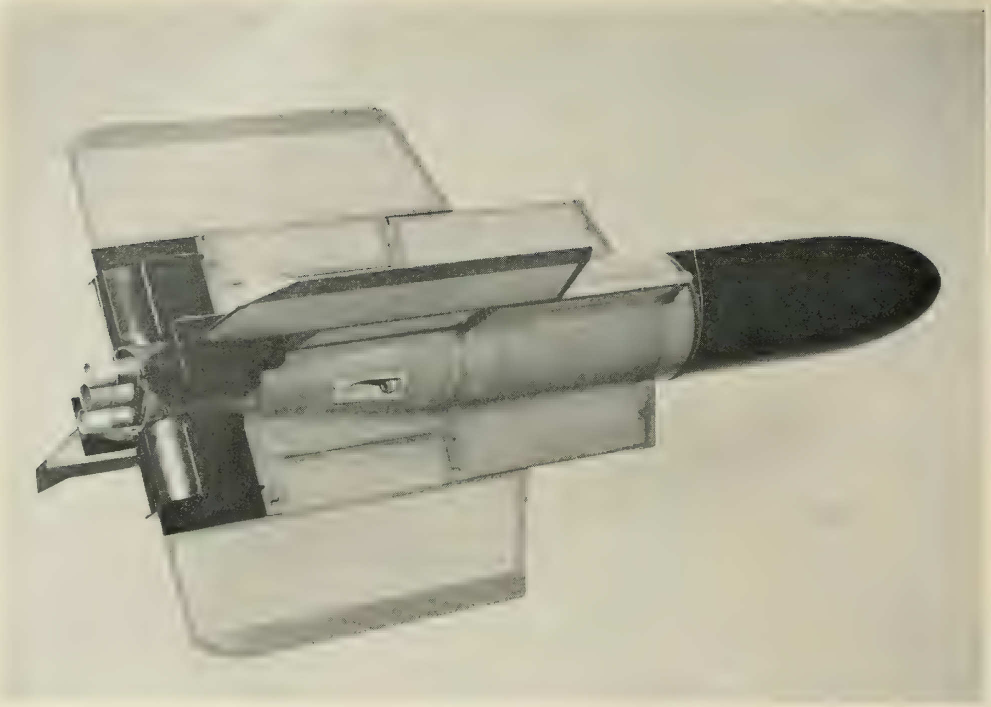


BANTAM

Sweden

Adam (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

CONFIGURATION: Length, 5.9 ft.; weight, 92.4 lbs.; HE warhead

GUIDANCE: None

Bantam (missile)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Range, 300 to 2,200 yds.

CONFIGURATION: Length, 33 in.; weight of container and missile, 24 lbs.

GUIDANCE: Wire

REMARKS: Lightweight, weapon uses double sheath fuze (dia. 110 mm) ensuring functioning at impact angle of 5° or after impact against protective tank devices.

Erika (missile)

TYPE: ASW, 375 mm

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Range up to 2,000 yds. Sinking speed six fathoms per sec.

CONFIGURATION: Length with proximity fuze, 6.5 ft.; weight with fuze and hexotonal charge, 550 lbs.

REMARKS: Can use inner solid-fuel motor and outer motor singly or together

Flora (missile)

TYPE: ASW, 375 mm

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Maximum range, 2,600 yds.

CONFIGURATION: Length with proximity fuze, 6.5 ft.; weight with fuze and hexotonal charge, 532 lbs.

Frida, Gerda (missiles)

TYPE: Air-to-Air

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

GUIDANCE: None

REMARKS: Gerda is the advanced system

Robot 304 (missile)

TYPE: Air-to-surface

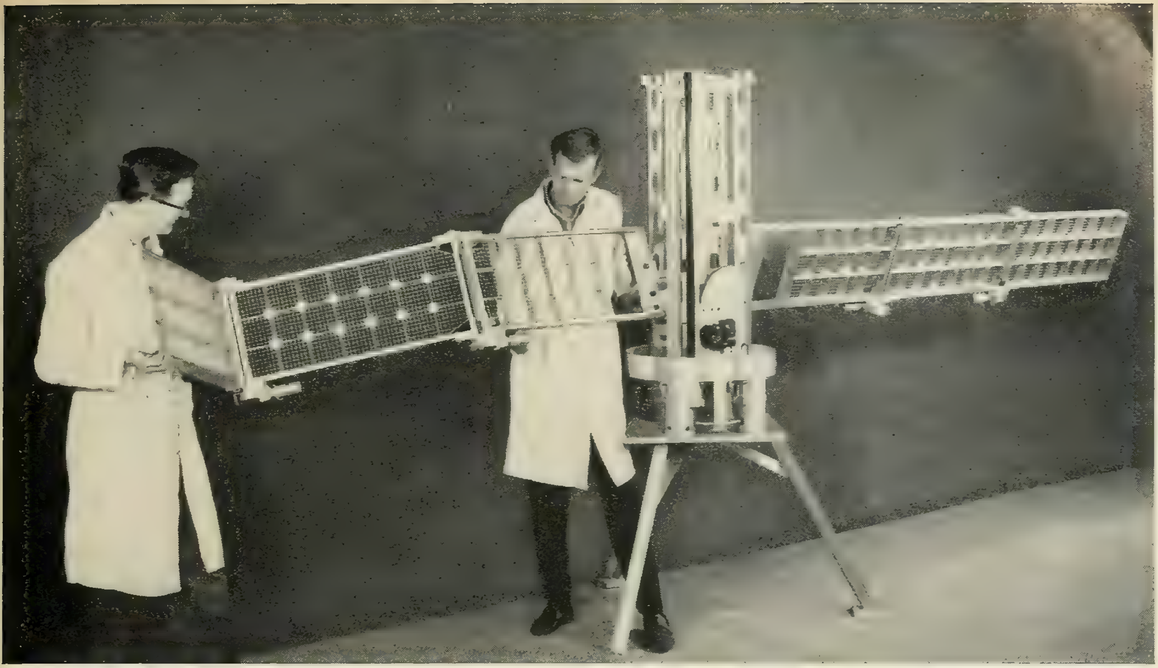
STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

CONFIGURATION: Length, 14.8 ft.; span, 6.4 ft.

GUIDANCE: Radio command

PROPULSION: Solid

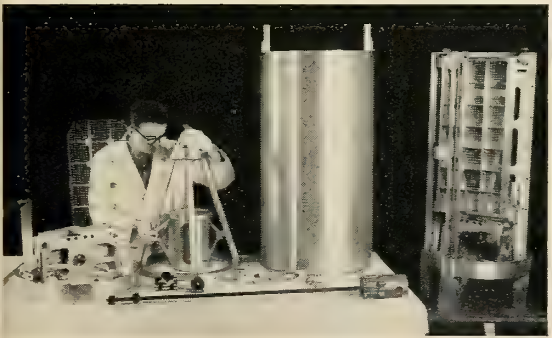


Heart of complex nuclear debris sampler being developed by Mechanical Specialties for the Sandia Corporation is the collecting arms—each made up of three folding sections.

We can make a dust-collector for use in Space

Atomic scientists believe that debris from upper atmosphere nuclear explosions is confined below 600,000 feet. Until now, though, sampling has been limited to about 120,000 feet. The assembly shown here is expected to nearly double sampling altitudes.

Rocketed aloft, the cannister with its two eight-foot blades folded inside floats earthward by parachute. At 225,000 ft. the filter-packed blades reach out, and small hydrogen peroxide fueled reaction motors on their tips set them spinning at 10 rps. Then, at a predetermined point of descent, they fold back into the instrument package and the complete assembly returns to Earth for laboratory analysis of the collected nuclear debris.



Some of the 1500 parts of the sampler—Every part is highly finished and precisely made to work like an instrument component. Folded arm assembly is at right, alongside cannister.

This space-age whirling dervish being developed for Sandia Corporation, Albuquerque, is an example of the advanced work for which Mech-Spec is qualified in the aerospace and nuclear fields. All mechanical and electrical aspects were handled by Mech-Spec with toolroom precision.

Whether your needs involve precision machining, tooling, special machinery, ground support equipment, or large or small assemblies, it will pay you to call in Mechanical Specialties. Ask our customers—they include every major aerospace company in the West. Write for our new 24-page brochure, "Experienced Pioneering," a complete photo-tour, with numerous examples of Mech-Spec's work.

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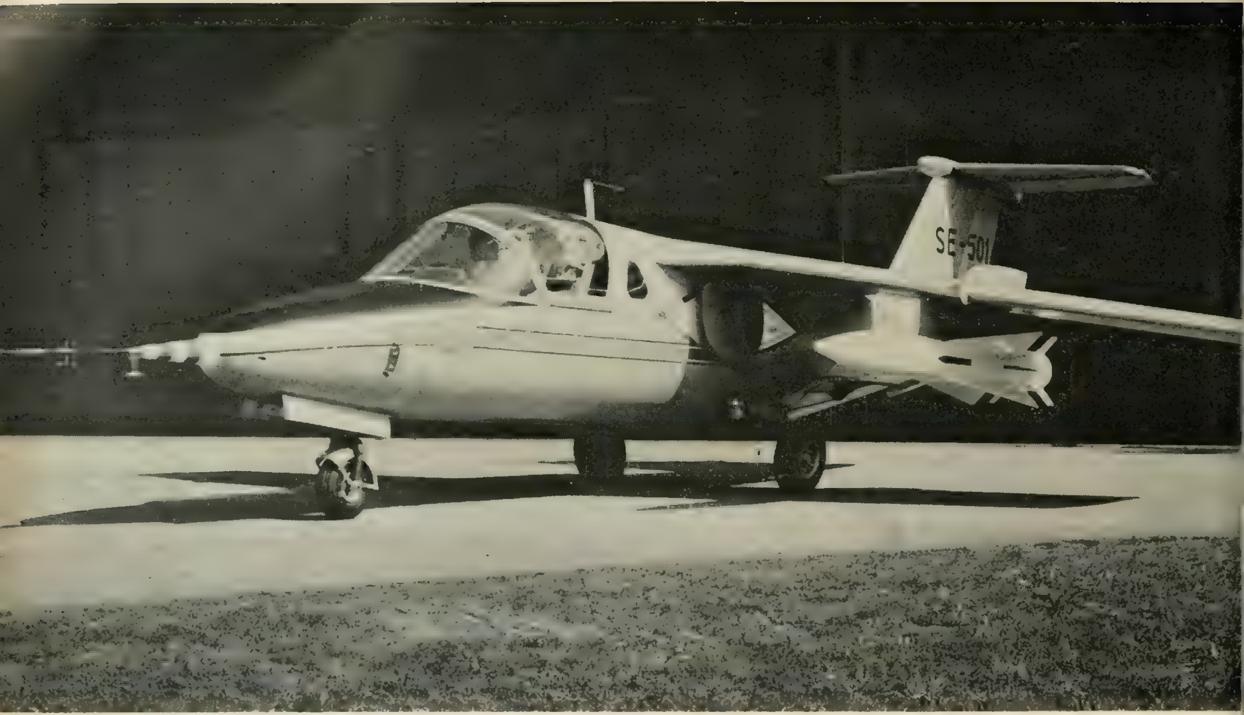


SAAB 'X'

Robot 315 (missile)

TYPE: Ship-to-shore

STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

CONFIGURATION: Length, 24 ft.

PROPULSION: Solid booster and solid sustainer

RRX-1 (rocket)

TYPE: Ramjet experimental vehicle

STATUS: R&D

PRIME CONTRACTOR: Svenska Flygmotor Aktiebolaget

PERFORMANCE: Mach 2 to 6

CONFIGURATION: Length, 6.9 ft.; diameter, 7.5 in.

Saab 'X' (missile)

TYPE: Air-to-surface

STATUS: Development

PRIME CONTRACTOR: Svenska Aeroplan Aktiebolaget

CHARACTERISTICS: Supersonic, 4 highly swept fins, control surfaces in rear

REMARKS: New missile system defined by Swedish air force for concurrent development with next-generation Saab 37 fighter. Few details released

Switzerland

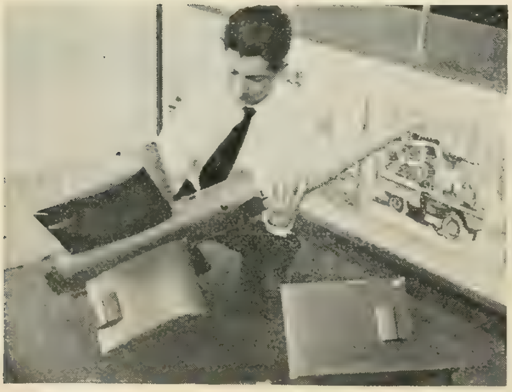
Sura 8-80 (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Hispano-Suiza (Suisse), S. A.

PERFORMANCE: Thrust, 2,640 lbs. In volley tests from aircraft at 497 mph, 50% dispersion was 10 milliradians



MOSQUITO

Mosquito (missile)

TYPE: Antitank

STATUS: Operational

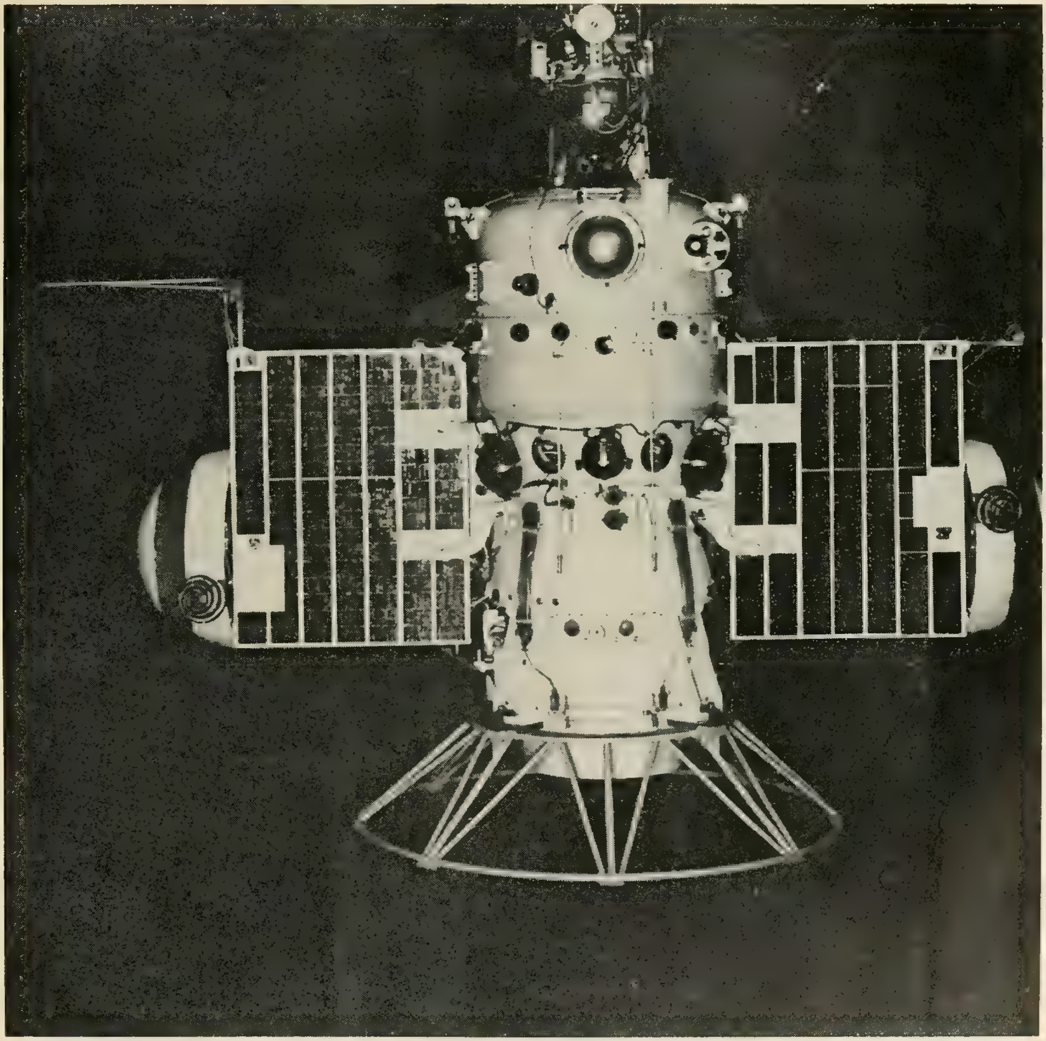
PRIME CONTRACTOR: Contraves AG

PERFORMANCE: 13 g in .8 sec. acceleration time; velocity 300 ft./sec.; max. range, 6,000 ft.; recoverable version has parachute triggered by operator.

CONFIGURATION: Total weight, 27.6 lbs.; control box, 17.6 lbs.; length, 43.7 in.; wingspan, 23.6 in.; shell diameter (w/h) 4.7 in.; armor plate penetration, over 24 in.

GUIDANCE: Wire

REMARKS: Several hundred units produced each month in joint manufacturing by Swiss Contraves and Italian Contraves plants



MARS I

Cosmos I-XVII

TYPE: Space research satellites

MISSION: Check and improve "elements of space vehicle construction" and carry out research into problems posed by the space environment

STATUS: Operational, frequent launches carried out

PERFORMANCE: Orbits ranging from 107 to 900 mi. altitude; angles of inclination are 49° and 65°

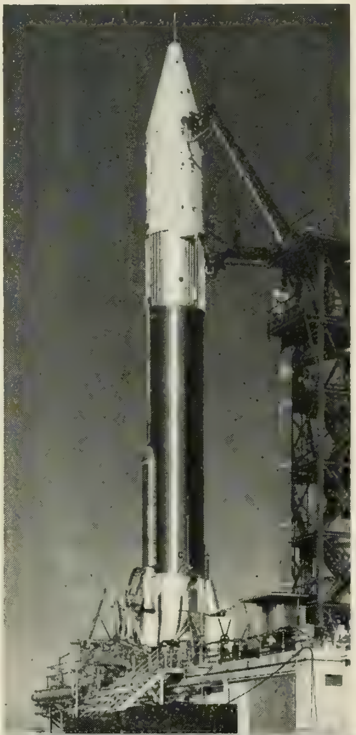
CONFIGURATION: Unavailable for entire series; believed to be larger than Vostok series

SPACE BOOSTER: Smaller, higher-powered military rocket which was tested by firing into the Pacific Ocean during fall of 1961

PAYLOAD: Particle counters; magnetometers, micrometeorite impact sensors, and possibly cameras for surveillance

REMARKS: One of most secretive Soviet space programs; has had many launches of alleged scientific nature, but scientific results have never been released; Cosmos program began in March, 1962, and has launched an average of one satellite monthly

for Space Information Systems, strength favors General Precision



General Precision's Information Systems Group (ISG) has built both major elements of a space information system. ■ One is the on-board subsystem that gathers space data and performs preliminary processing. Proof of capability: a Librascope computer aboard NASA's Atlas-Centaur will be the first to guide a space vehicle to a soft landing on an extraterrestrial body. ■ The other is the ground-based subsystem that completes the processing and displays the desired information after transmission from the spacecraft. Proof of capability: A Librascope multiple-computer system will play a key role in USAF's 473L command-and-control system to be installed in the Pentagon. ■ Send for the story of ISG's 25 years in environmentally designed information systems and latest work on advanced computing techniques.

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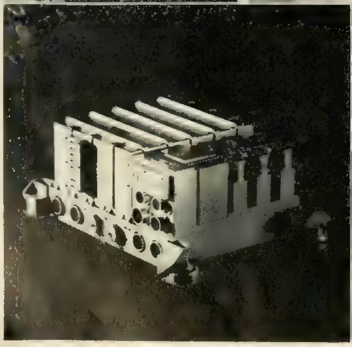

G2-1044

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Lunik I-IV

TYPE: Space and lunar research vehicles

STATUS: Four flights—Jan. 2, Sept. 12, Oct. 4, 1959, and April 2, 1963. Lunik I—solar orbit; Lunik II—impacted Moon; Lunik III—photographed far side of Moon and presumably burned up in Earth's atmosphere in April, 1960; Lunik IV—passed within 5,300 miles of Moon, went into deep Earth orbit and is expected to go into solar orbit. No indication of objectives or success of Lunik IV available

FRAME: Lunik I & II—dimensions not released; total weight, 3,245 lbs., instruments, 800 lbs. for I and 858 lbs. for II; Lunik III—cylindrical, length 87 in., diameter 47 in.; weight, 4,037 lbs. total, 959 lbs. instruments; Lunik IV—dimensions unavailable; weight, 3,135 total

INSTRUMENTATION: Internal temperature and pressure measurement instruments; devices to study gas components of interplanetary matter and corpuscular radiation of Sun, magnetic fields of Earth and Moon, meteoric particles and heavy nuclei in primary cosmic radiation; Lunik III also had two cameras, developing equipment, and automatic triggering devices for cameras, resulting in transmission of photos of far side of Moon

SPACE BOOSTER: Believed to be modified T-3 three-stage ICBM

REMARKS: Lunik II impacted on the moon with instrumentas and a Soviet coat-of-arms; was also called Mechta (Dream). Lunik III transmitted photographs showing 70% of Moon's far side; Lunik IV took longer than usual to get to Moon, missed by 5,281 miles, and accomplished no apparent landing or photography. Tass reported, however, that it was a success. It is believed an attempted soft-landing by Lunik IV failed

Vostok I-VI

TYPE: Manned spacecraft

STATUS: Single flights, Vostok I, April 12 & Vostok II, Aug. 6, 1961; two double flights, Vostok III & IV, Aug. 11/12, 1962; and Vostok V & VI, June 14/16, 1963

PERFORMANCE: Vostok I, one orbit at 187/108 mi.; Vostok II, 17½ orbits at 115/110 mi.; Vostok III, 64 orbits at 145/112 mi.; Vostok IV, 48 orbits at 147/111 mi.; Vostok V, 82 orbits at initial 130/108 mi.; Vostok VI, 49 orbits at 133.9/109 mi.

FRAME: Overall length (est.) 35 ft.; diameter (est.) 8.8 ft.; re-entry body (est.) 17 ft.; total weight, Vostok I, 10,418 lbs.; Vostok II, 10,430 lbs.; Vostok III, "about 5 tons;" Vostok IV, same; Vostok V, same; Vostok VI, same

INSTRUMENTATION: Radio & TV equipment for biomedical monitoring, automatic life support equipment; both automatic and manual control equipment; biomedical specimens for radiation experiments

SPACE BOOSTER: Not revealed

REMARKS: Two near-rendezvous double flights have been carried out by the USSR, and the second seemed to go awry. Vostok VI carried a woman; Vostok V appeared to be in improper orbit, which decayed rather rapidly and was considerably different from that of its running mate, preventing any possibility of rendezvous

Venus Probes

TYPE: Interplanetary probe launched from Earth satellite

STATUS: At least four attempts known; no successes

PERFORMANCE: Poor; difficulty in transferring from parking orbit to interplanetary trajectory; first probe missed Venus by over 600,000 miles; remainder have been stymied while still in Earth orbit

CONFIGURATION: Probe—cylindrical payload; length, 80 in.; diameter, 41 in. without solar paddles and antennas; weight, 1,419 lbs.; configuration of Earth satellite vehicle unknown

INSTRUMENTATION: Cosmic radiation, magnetic field, micrometeorite, and other detectors; stabilization, temperature control, telemetry and other control equipment

REMARKS: Most recent attempt was May 22, 1963, but vehicle apparently disintegrated while still in Earth orbit, NASA lists rocket stages & 24 pieces in orbit but no transmission information; considerable difficulty experienced by USSR in transferring all interplanetary vehicles from Earth orbit. Sputnik VII, Sputnik VIII and the unnamed May 22 satellite are considered abortive attempts. Only probe to make the transfer missed target planet by a wide margin

Mars I

TYPE: Unmanned interplanetary Probe

STATUS: One flight, Nov. 1, 1962

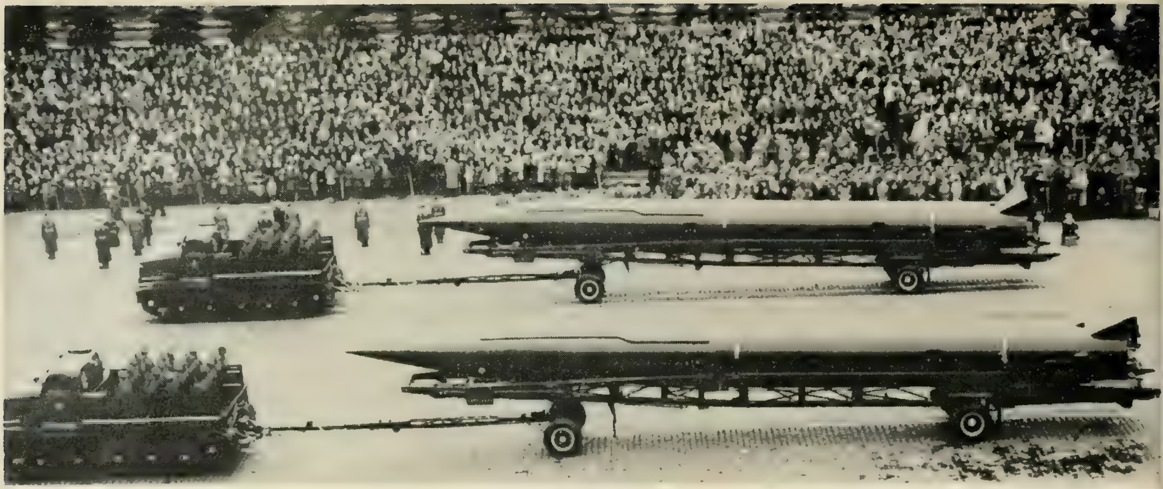
PERFORMANCE: Speed after Earth escape, 8,793 mph. Data on Earth's radiation belts as well as space measurements at distances up to 66 million miles from Earth were successfully transmitted

CONFIGURATION: Two hermetically sealed compartments, orbital and planetary. Maximum length 10 ft. 10 in., 3 ft. 7 in. diameter in the orbital compartment, maximum width 13 ft. 1½ in. including solar batteries and radiators. Weight 1,907 lbs.

INSTRUMENTATION: Photo television assembly for photographing Martian surface. Spectro-flexometers, spectograph, magnetometers, radio telescope, sensors to measure low-energy protons and electrons

POWER: Chemical and solar batteries

REMARKS: Mars probe launched on interplanetary trajectory from Earth orbit. Soviets predicted vehicle would come within 120,000 miles of Mars without a mid-course guidance correction. Radio contact with spacecraft lost



T-2's

Missiles

T-1 (Army)

TYPE: Surface-to-surface MRBM

STATUS: Operational

PERFORMANCE: Range, 400-600 mi.

FRAME: Length, 62 ft.; weight, 44,000 lbs.; single stage

REMARKS: Mobile. LOX/alcohol-fueled booster generates 77,000 lbs. thrust. Radio-guided. Nuclear capability

T-2 (Army)

TYPE: Surface-to-surface IRBM

STATUS: Operational

PERFORMANCE: Range, 1,300-1,500 mi.; speed, 5,000 mph

FRAME: Length, about 66 ft.; weight, 55 tons; two stages.

PROPULSION: 1st stage, 1R-14A; type, liquid (LOX/kerosene); thrust, 268,000 lbs.; 2nd stage, 1R-10; type, liquid (LOX/alcohol); thrust, 78,000 lbs.

REMARKS: T-2 reportedly was first Soviet rocket used to test H-bomb warhead. Fired from Central Russia, warhead was exploded at 120,000 ft. near Bennet Island in the Arctic

T-3 (Air Force)

TYPE: Surface-to-surface ICBM

STATUS: Operational

PERFORMANCE: Range, 5,000 mi.; speed, 15,000 mph; apogee, 280 mi.

FRAME: Length, 88 ft.; diameter, 11.5 ft.; weight, 176,000 lbs.

PROPULSION: 1st stage, 2R-14; type, liquid (LOX/kerosene); thrust, 440,000 lbs.; 2nd stage, 1R-14A; type liquid (LOX/kerosene); thrust, 268,000 lbs.; 3rd stage, 1R-10; type, liquid (LOX/alcohol); thrust, 78,000 lbs.

REMARKS: Radio-inertial-guided. Production reportedly completed. Improved T-3 has 6,500-mi. range. Nuclear warhead

T-3A (Army)

TYPE: Surface-to-surface ICBM

STATUS: Operational

PERFORMANCE: Range (Model A), 6,000 mi.; range (Model B), 7,500 mi.; speed, 15,000 mph

FRAME: A—length, 92 ft.; diameter, 12 ft.; weight, 182,600 lbs. B—length, 102 ft.; diameter, 16 ft.; weight, about 400,000 lbs.

PROPULSION: A Model: 1st stage, 2R-14A engines; type, liquid (LOX/kerosene); thrust, 518,000 lbs.; 2nd stage, 1R-14A; type, liquid (LOX/kerosene); thrust, 268,000 lbs.; 3rd stage, 1R-10; type, liquid (LOX/alcohol); thrust, 78,000 lbs.; B Model: 1st stage, 4R-14A; thrust, 820,000 lbs.; 2nd stage, same as A model; 3rd stage, same as A model

RREMARKS: Production of Model A ceased. Booster stage on Model B believed to be prototype for one used in T-4A antipodal missile. Nuclear warhead

T-4A (Air Force)

TYPE: Surface-to-surface ICBM

STATUS: Development

PERFORMANCE: Range, over 10,000 mi.; apogee, 186.3 mi.; speed, 13,660 mph

FRAME: Length, 121.02 ft.; wing span, 65.6 ft.; max. diameter, 10.2 ft.; launch weight, 230,000 lbs.

PROPULSION: 1st stage, 4 solid propellant rocket motors; thrust, 268,000 lbs.; 2nd stage, 1R-14A; type, liquid (LOX/kerosene); thrust, 268,000 lbs.; 3rd stage, 1R-10; type, liquid (LOX/alcohol); thrust, 78,000 lbs.

REMARKS: Catapulted from rail sled. Payload, 2,350 to 3,100 lbs. Radio-guided. Antipodal bomber is Soviet counterpart of U.S. X-20 boost-glide spacecraft stemming from the German Saenger-Bredt design conceived in World War II

T-6 (Army)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 20-25 mi.; speed, 1,500 mph; ceiling, about 60,000 ft.

FRAME: Length, 22 ft.; diameter, about 3 ft.; weight, about 4,000 lbs.

WARHEAD: HE with proximity fuze

PROPULSION: Booster, 4 solid-propellant motors; thrust, 11,000 lbs.; sustainer, 2 solid-propellant motors; thrust, 2,200 lbs.

REMARKS: Fired from multiple launcher. Radar-guided and believed to be operational

T-5B (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 15-25 mi.

FRAME: Length, 31 ft.; diameter, 3 ft.; weight, 6,000 lbs.

PROPULSION: Type, solid; thrust, 22,000 lbs.

REMARKS: Similar to U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly nuclear warhead 5C model (similar to U.S. Little John) in production

T-7A (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 50 to 90 mi.; speed, Mach 5

FRAME: Length, about 30 ft.; diameter, 2.5 ft.; weight, about 9,000 lbs.

PROPULSION: Solid-propellant; thrust, 11,450 lbs.

WARHEAD: HE

REMARKS: Comparable to U.S. Corporal. Has controllable rear fins, radio command guidance

T-8 (Army, Air Force)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 15 to 25 mi.; speed, Mach 2.5; ceiling, 79,280 ft.

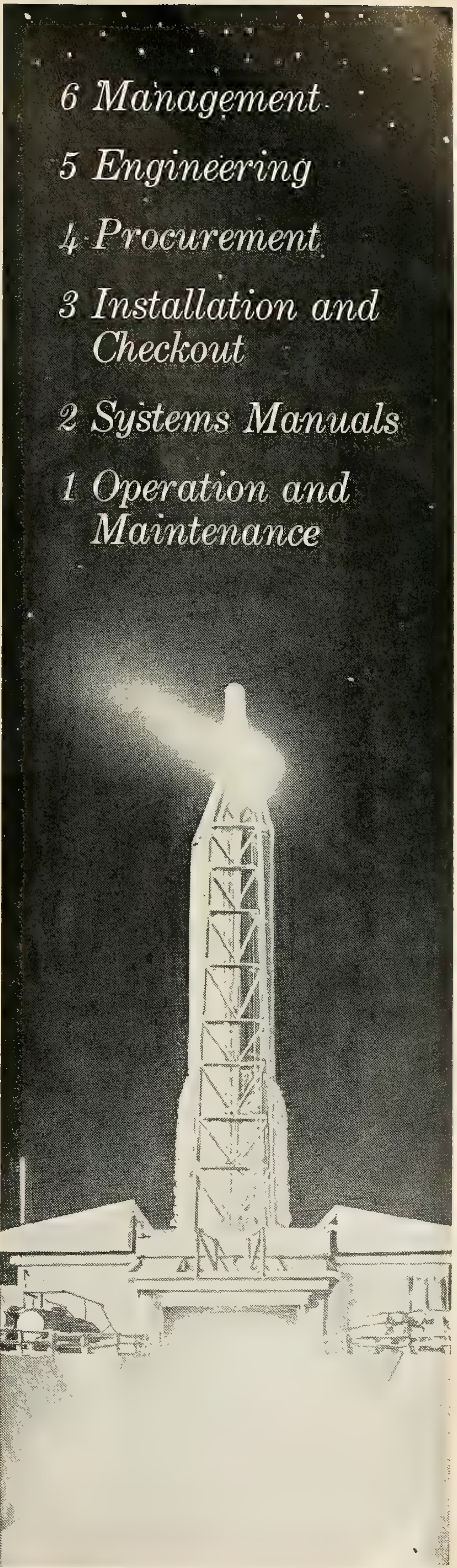
FRAME: Length, 13 ft.; diameter, 1.05 ft.; weight, 2,090 lbs.

PROPULSION: First stage, cluster of two solid fueled boosters; thrust, 4,000 lbs.; second stage, liquid; thrust, 4,600 lbs.

WARHEAD: HE with proximity fuze

REMARKS: IR guidance. Deployed in East Germany in batteries of six launchers

COUNTDOWN ON RELIABILITY



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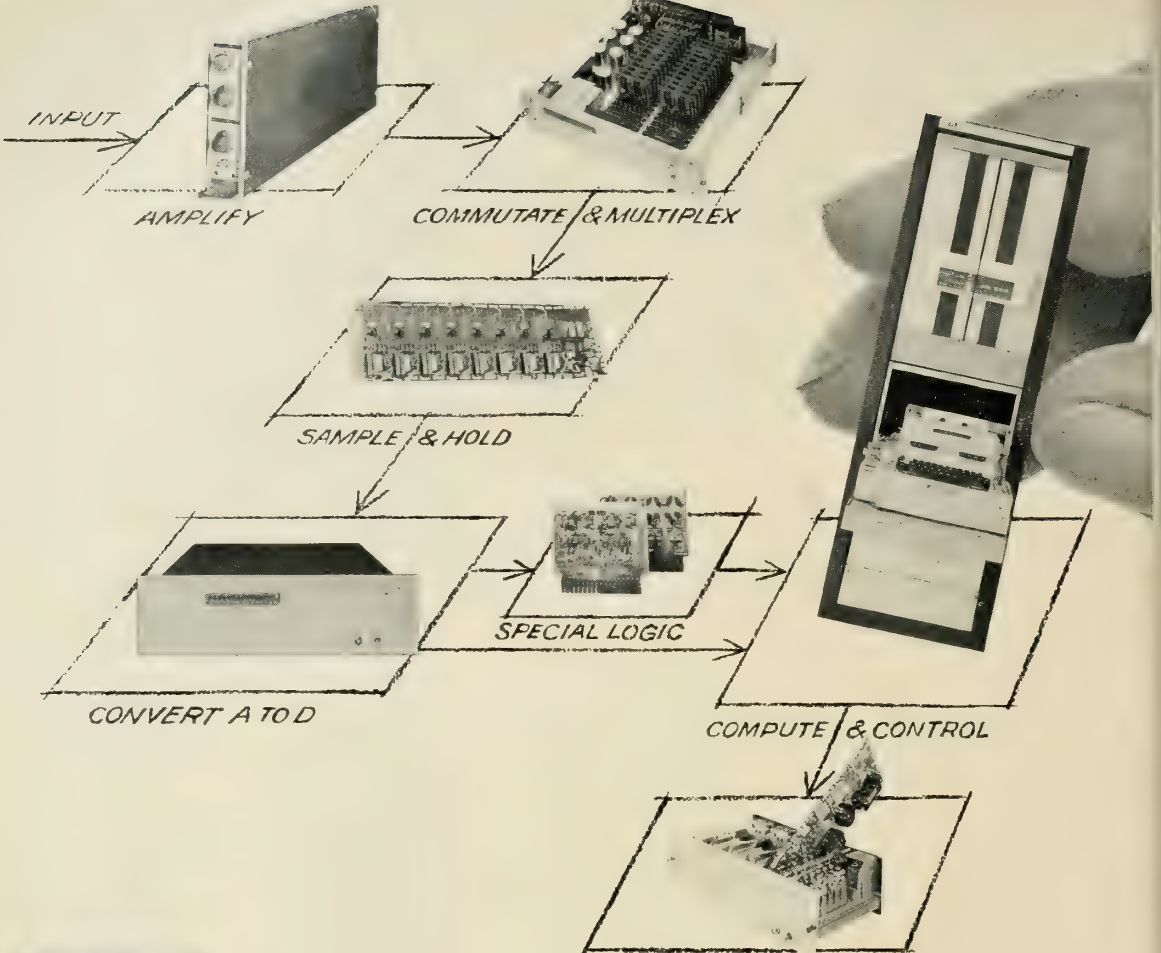

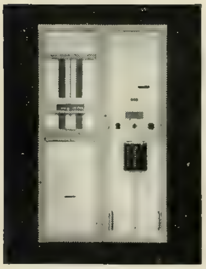

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Komet I (Navy, CH 17 Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 100 mi.; speed, 3,000 mph

FRAME: Length, 37 ft.; diameter, 4 ft.; weight, 20,250 lbs.

PROPULSION: Type, solid; thrust, 53,000 lbs.

REMARKS: Program under way to put Komet I into service aboard submarines and surface ships. HE and nuclear warheads

Komet II (Navy, CH 18 Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 400 mi.; speed, Mach 7.5

FRAME: Length, 42 ft.; diameter, 5.9 ft.; weight, 41,350 lbs.

PROPULSION: Type, solid; thrust, about 100,000 lbs.

REMARKS: Operational with Red Army and from surface vessel in calm waters. R&D for submarines. Nuclear warhead

Komet D (Air Force)

TYPE: Air-to-surface standoff

STATUS: Development

PERFORMANCE: Range, 55 mi.; speed, Mach 1

FRAME: Length, 15 ft.; diameter, about 4 ft.

PROPULSION: Type, solid; thrust, 5,000 lbs.

REMARKS: Equivalent to British Avro, turbojet-propelled missile may have beam-riding guidance. Warhead can be nuclear or HE

M-2 (Army, Navy)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 37 mi.; speed, Mach 2; ceiling, 68,000 ft.

FRAME: Length, about 25 ft.; diameter, 18 in.; weight, 3,970 lbs.

PROPULSION: Booster, solid; thrust, 9,350 lbs.; sustainer, solid; thrust, 4,600 lbs.

REMARKS: Mobile. Infrared, radar, or both used as guidance. Advanced version reported to have 150,000 ft. ceiling

M-100A (Air Force)

TYPE: Air-to-air

STATUS: Operational

PERFORMANCE: Range, 3½ mi.; speed, Mach 2.5

FRAME: Length, 53 in.; diameter, 3 in.; weight, 85 lbs.

REMARKS: Solid-fueled, semi-active radio-radar command guidance

ME-Igor (Army)

TYPE: Antitank

STATUS: Operational

PERFORMANCE: Range, over 2 mi.; speed, Mach .7

FRAME: Length, 48 in.; diameter, 3 in.; weight, 10.5 lbs.

REMARKS: Solid-fueled. Fired from bazooka tube. HE warhead

RS-132A (Air Force)

TYPE: Air-to-surface

STATUS: Operational

FRAME: Length, about 4 ft.; diameter, 5.2 in.

PROPULSION: Solid-propellant motor

REMARKS: HE warhead; mounted on helicopter and aircraft for ASW and air-ground missions

Golem I (Navy)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 400 mi.; speed, Mach 7; altitude, 125 mi.

FRAME: Length, 54 ft.; diameter, 5.5 ft.; weight, 16½ tons gross

PROPULSION: Type, liquid; thrust, 120,000 lbs.

REMARKS: Developed from German World War II plans for seagoing V-2 (A-3). Radio-inertial guidance. Designed to be launched from capsule towed by submarine Nuclear capability

Golem II (Navy)

TYPE: Underwater-to-surface

STATUS: Operational

PERFORMANCE: Range, 400 mi.;

FRAME: length, nearly 60 ft.; diameter, 7 ft.; weight, 75,000 lbs.

PROPULSION: Booster, liquid; thrust, 240,000 lbs.; sustainer, liquid; thrust, 72,000 lbs.

REMARKS: Advanced version of Golem I with improvements adopted from Army T-2. Probably radio-inertial guidance, liquid-fueled. Nuclear capability

Golem III (Navy)

TYPE: Underwater-to-air, surface-to-air

STATUS: Operational on surface vessels. Development for land-based version

PERFORMANCE: Range, 10 mi.; ceiling, over 65,000 ft.

FRAME: Length, over 15 ft.; diameter, 20 in.; weight, about 4,500 lbs.

REMARKS: Solid-fueled, infrared-guided. Designed to give submarine and surface ships antiaircraft protection

J-3 (Navy, Army)

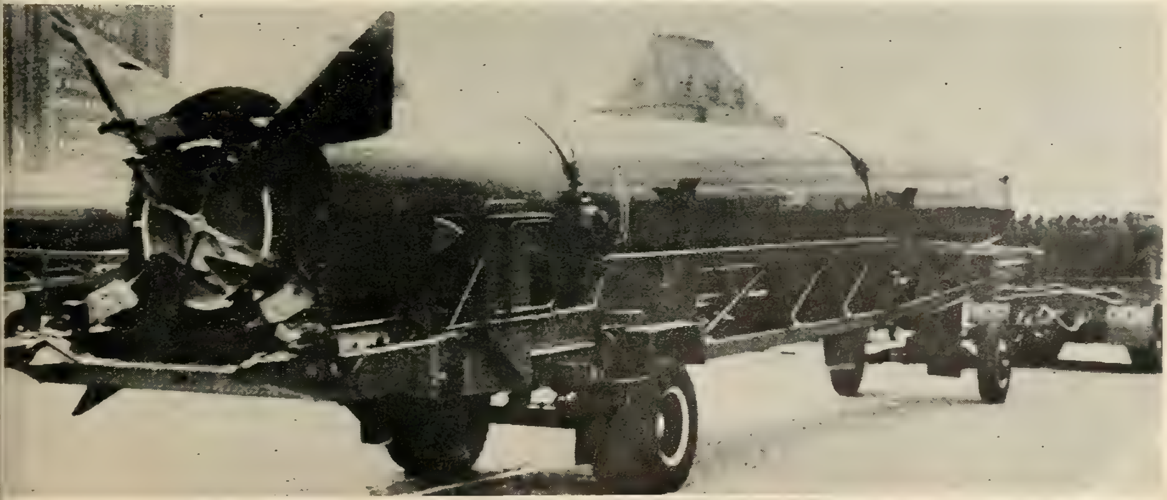
TYPE: Surface-to-surface

STATUS: Operational with Red Army and at least 7 Baltic fleet cruisers

PERFORMANCE: Range, 450-600 mi.; speed, supersonic

FRAME: Length, 36 ft.; diameter, 4.5 ft.; weight, over 20,00 lbs.

REMARKS: Booster is cluster of 4 solid-fuel rockets; ramjet sustainer. Guidance presumably beam-riding or programmed. Nuclear capability



T-1

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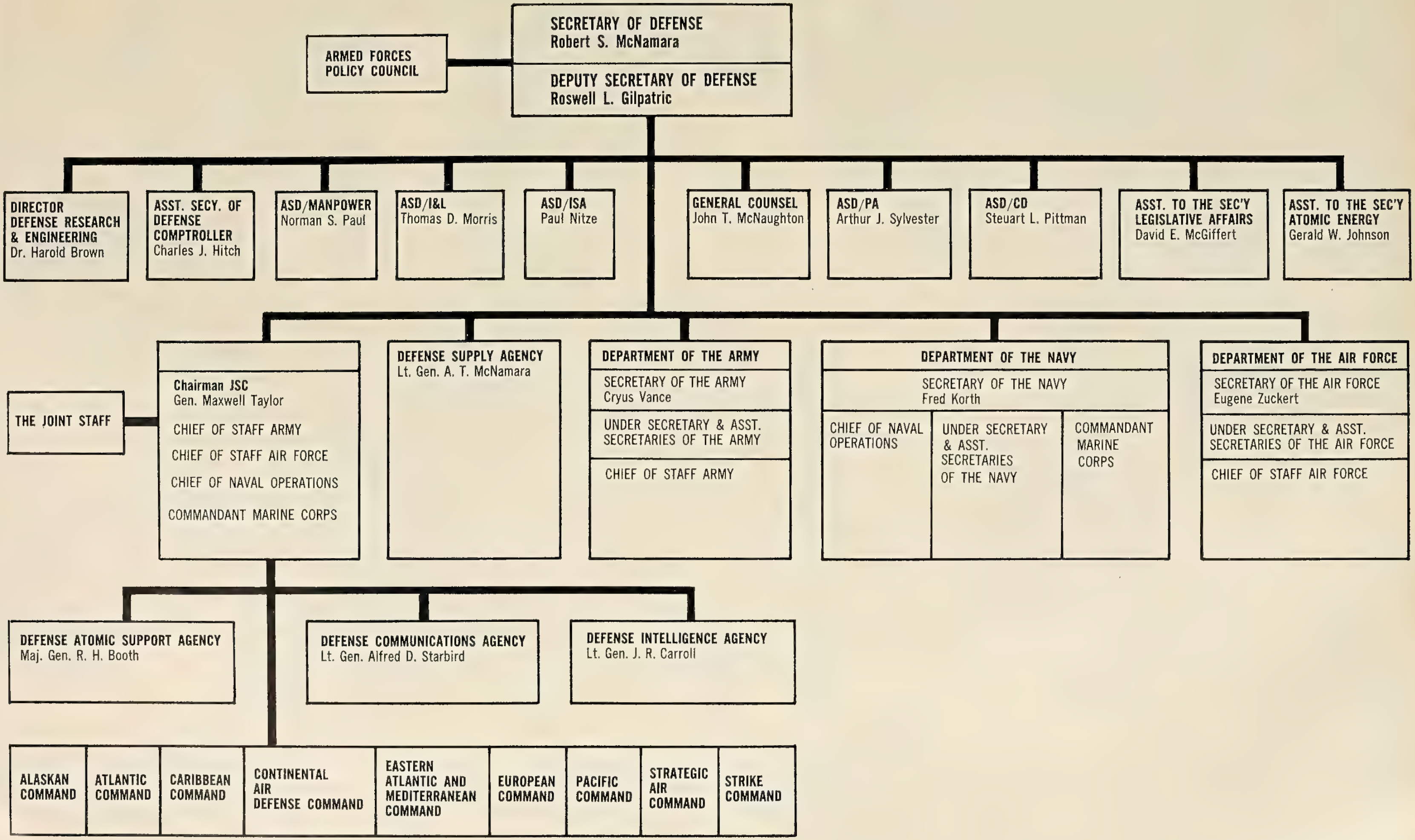
DEPARTMENT OF DEFENSE



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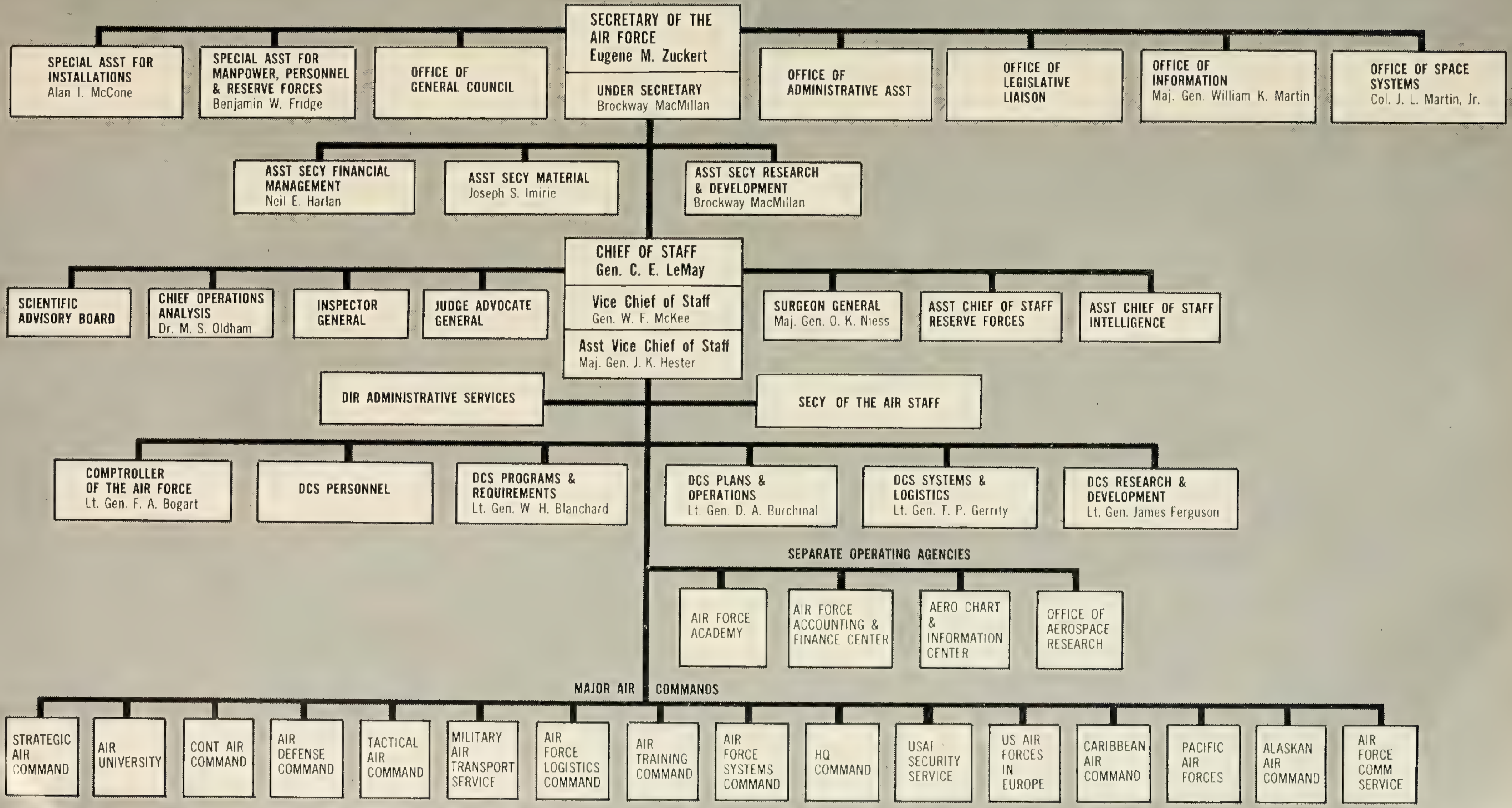
OFFICE SECRETARY OF THE AIR FORCE AND THE AIR STAFF



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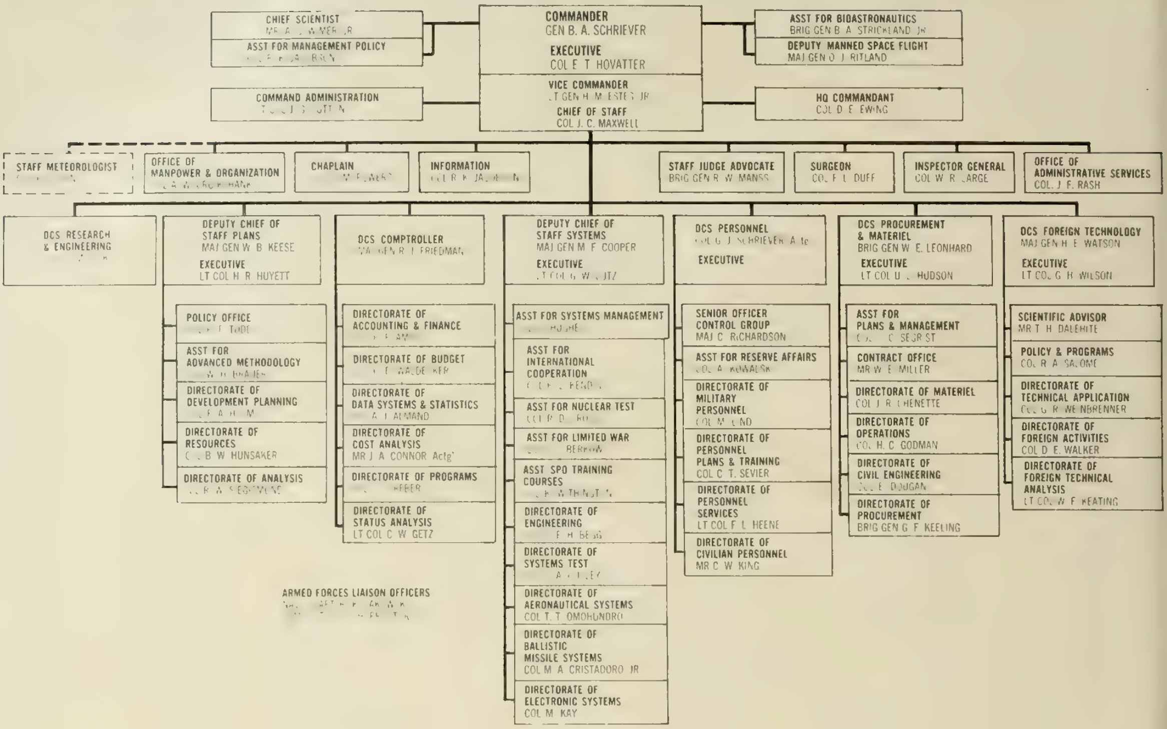

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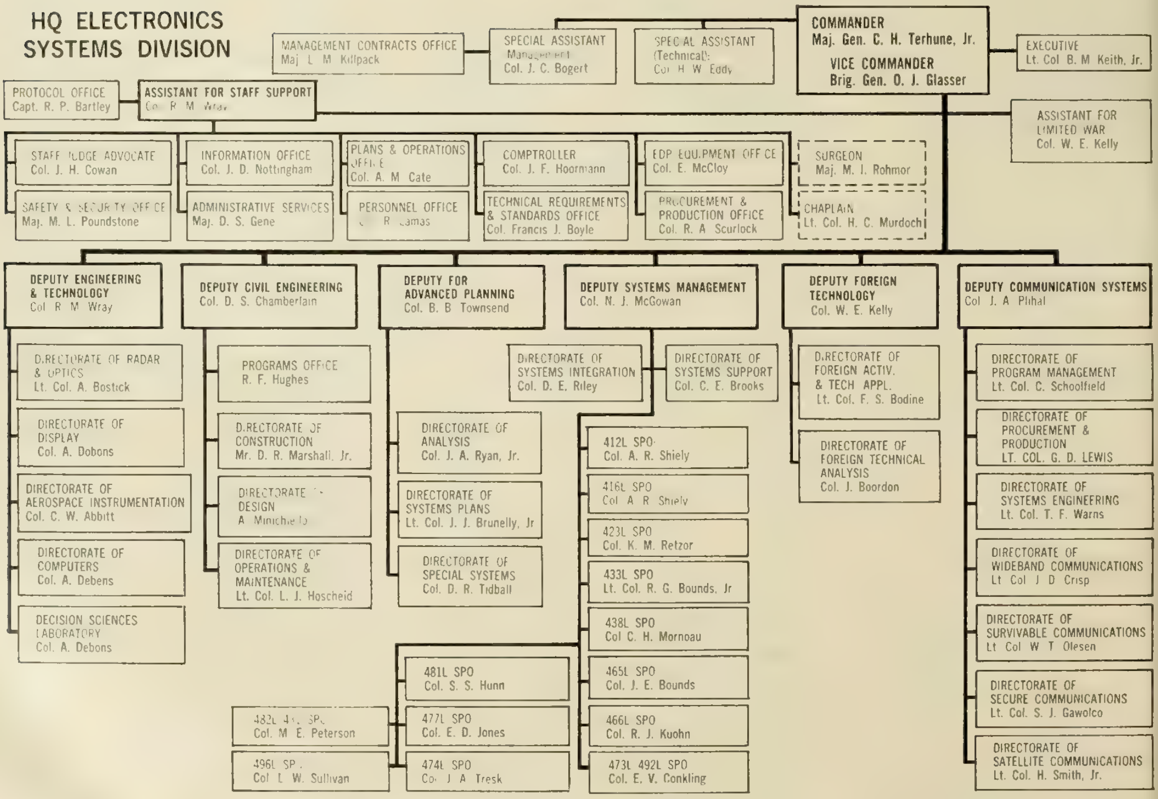

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AC recently developed a new stellar inertial guidance system for space exploration and mobile missiles; and AC is now participating in the engineering and production of the navigational system for Project APOLLO.

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AC's Stellar Inertial Guidance System provides both the extreme accuracy and rapid targeting capabilities required for a variety of ballistic missile systems. Shown below is a mock-up of this type of system which employs a star scanning device to refine azimuth information after the missile has been launched.

MASTER NAVIGATORS THROUGH TIME AND SPACE

AC SPARK PLUG • THE ELECTRONICS DIVISION OF GENERAL MOTORS

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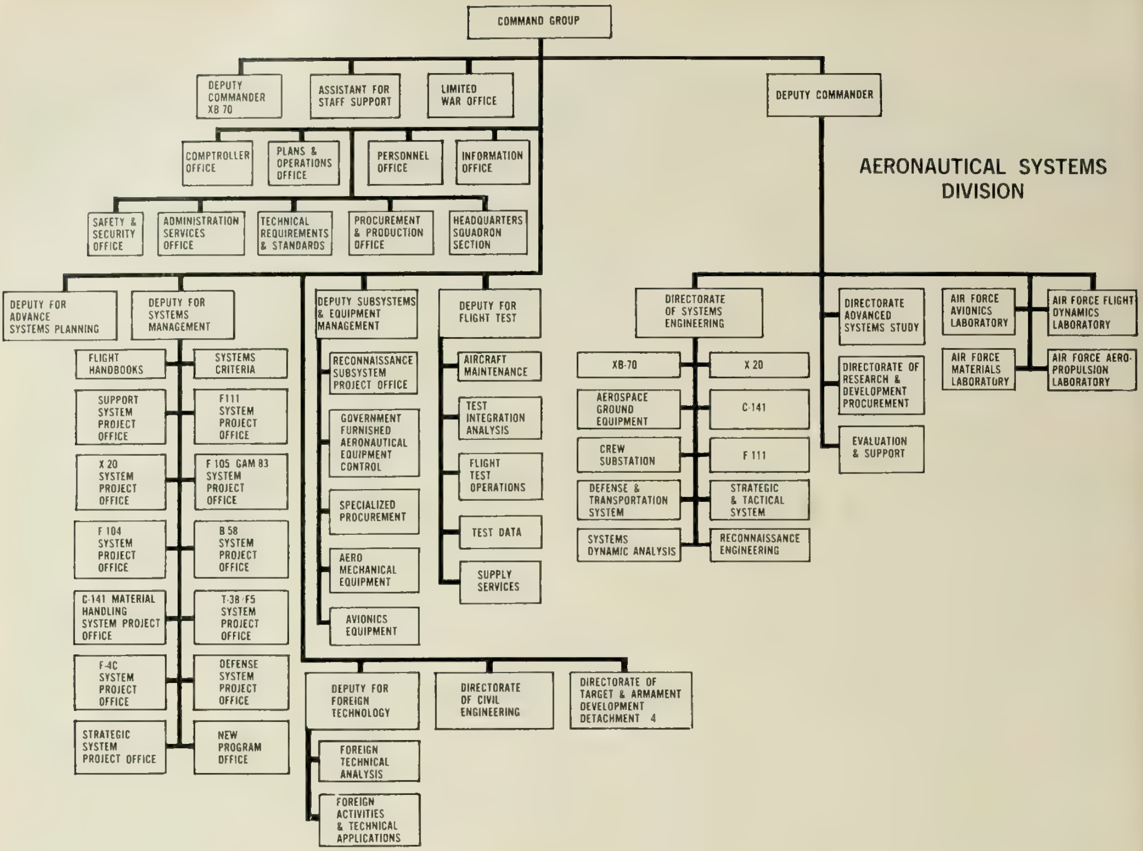
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F 105 GAM 83 SYSTEM PROJECT OFFICE
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B 58 SYSTEM PROJECT OFFICE
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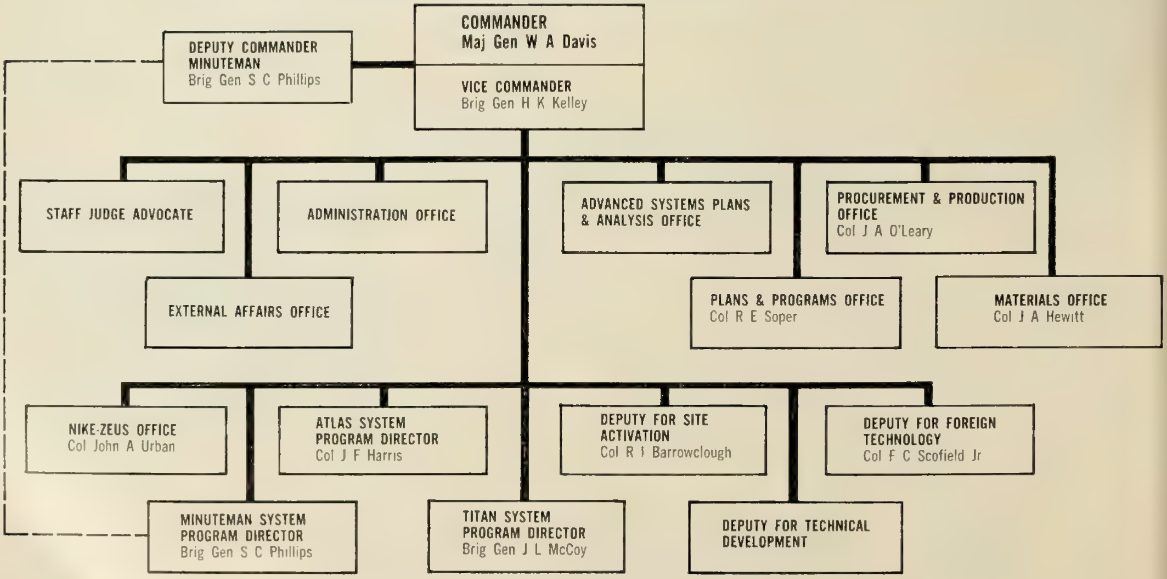
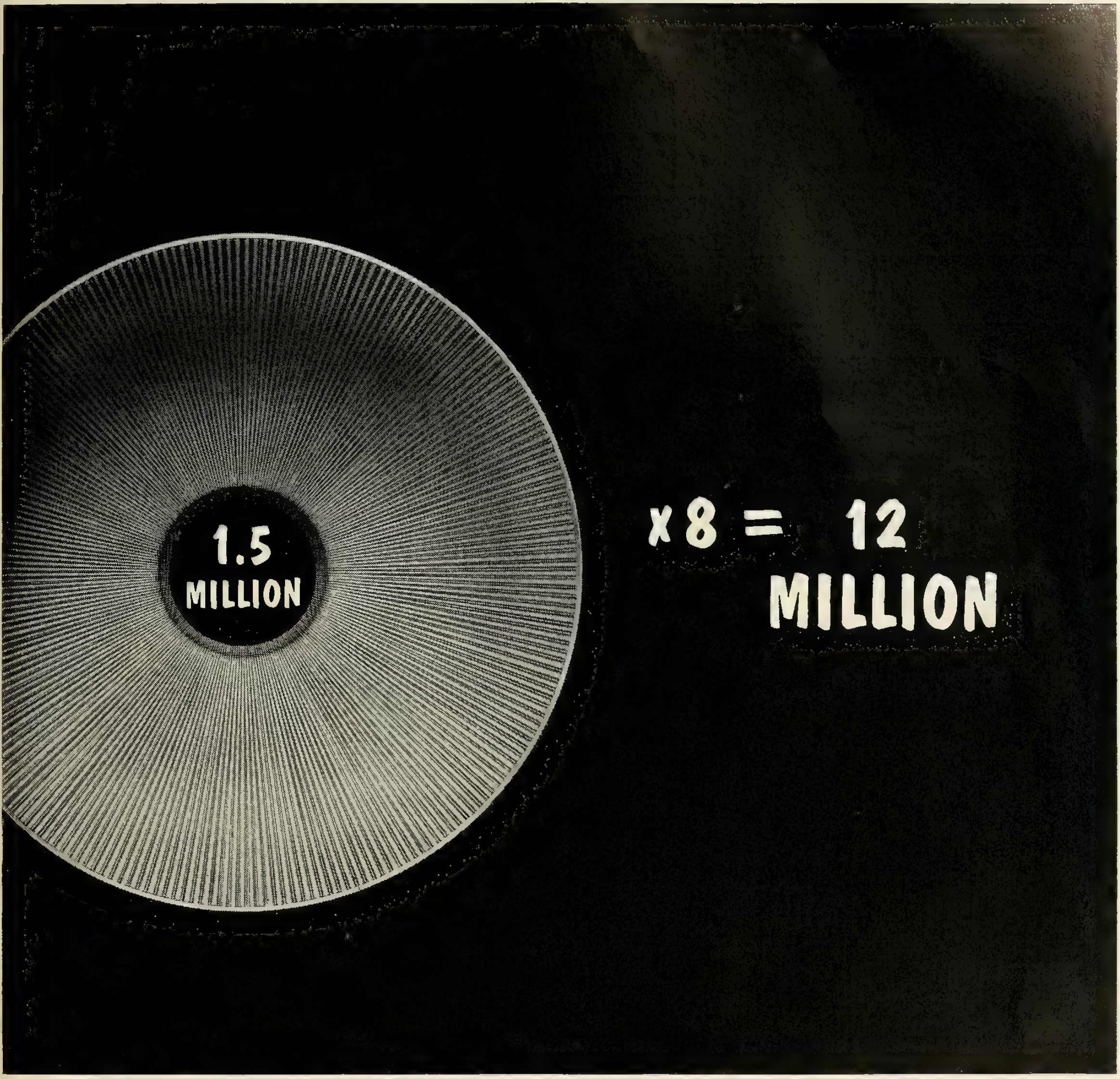


Tomorrow's tubing technology—today



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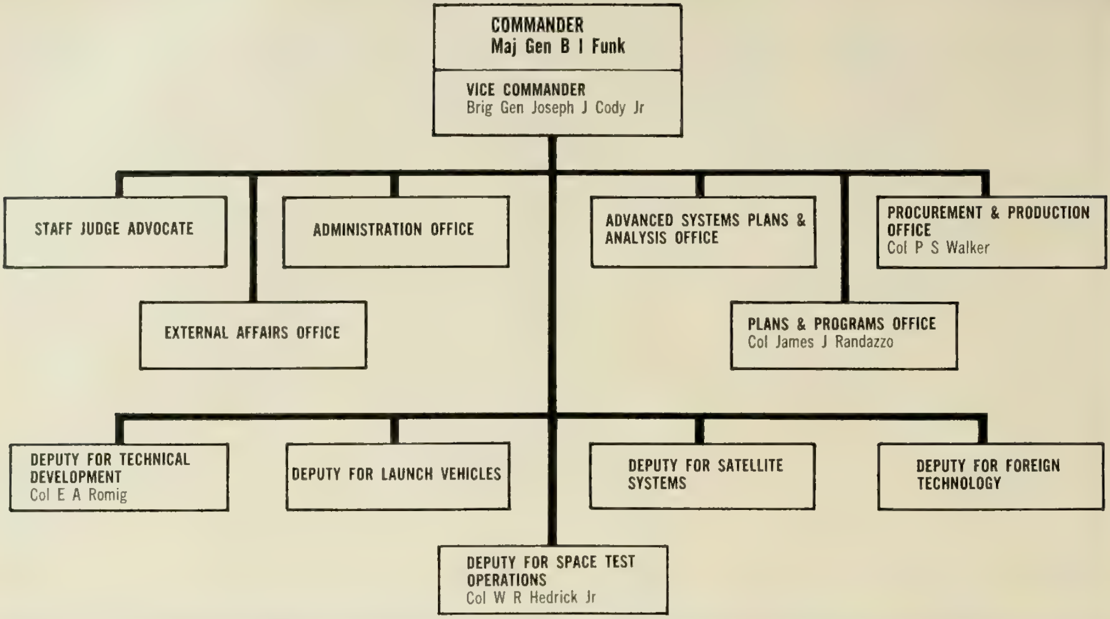
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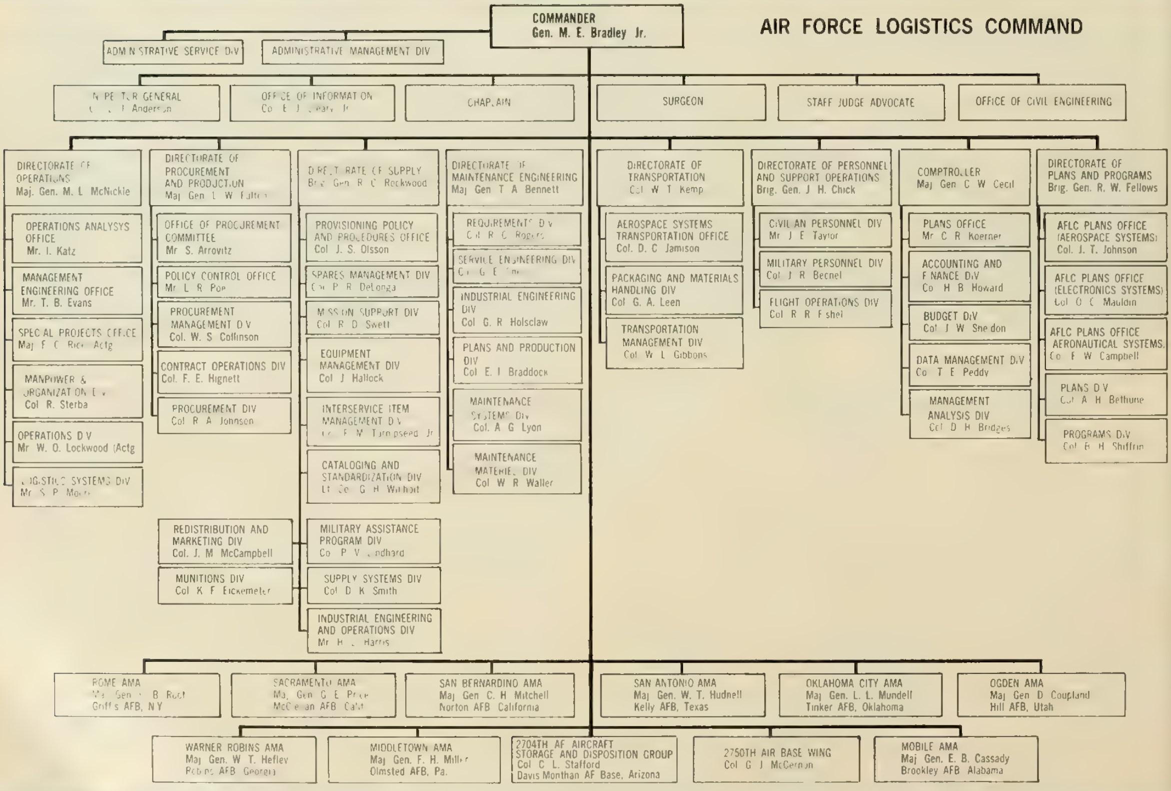
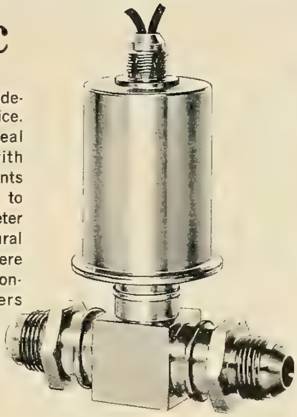


Valcor Aerospace Solenoid Valves

for extremes in temperature, corrosion and flow

Cryogenic

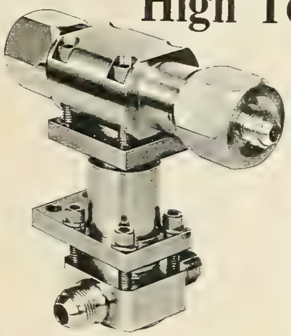


Series 446 Specifically designed for liquid gas service. A gate type floating-seal valve. Direct acting with straight line flow. All joints are inert heli-arc welded to guarantee mass spectrometer leak tightness and structural soundness in the most severe applications. All steel construction. No elastomers used — anywhere.

Specifications:

Temperature range	−452°F to +600°F
Max. operating pressure	up to 2300 psi
Leakage	liquid, $\frac{1}{2}$ cc/hr. maximum
Voltage	18-30 V. DC
Current	1.3 amps max. @ 30 V. DC 70°F
Dielectric	1000 volts RMS minimum

High Temperature

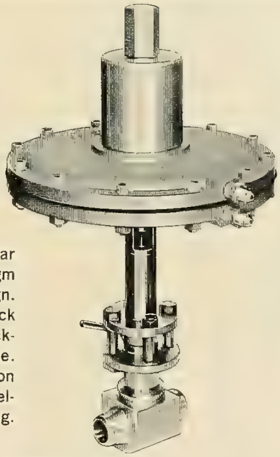


Series 420 for control of metal vapors and molten metals . . . typical examples are liquid potassium, lithium, cesium, sodium and others. It is a floating, shear-seal type with straight-through flow. Valve may be activated directly or remotely; pneumatically, electrically or manually. Variable orifice feature. This unique design has a **proven** record of reliability in actual usage.

Specifications:

Temperature	up to 2200°F
Max. operating pressure	500 psi. Higher pressures at lower temperatures
Leakage	external — zero internal — 0.01% rated flow max. Tighter control is possible depending on application.
Ports	available from $\frac{1}{4}$" to 1" O.D. tubing

Nuclear



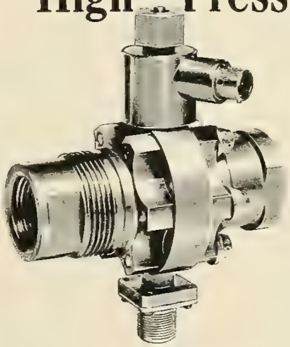
Series 427 Excellent for high temperature, vacuum and/or corrosive service. This valve series is a bellows seal (diaphragm type) pneumatically operated 2-way shut-off design. Its major usage has been in nuclear applications. The diaphragm is a spring-loaded design. Construction contains back seating and secondary packing. Plug is replaceable. Hexagon anti-torque section prevents damage to the bellows from possible twisting.

Specifications:

Temperature	—423°F to 1500°F
Leakage	Internal (seat) Liquid: 1/10 cc/hr. Gas: 1 cc/hr. per 1/10" seat diameter With soft seal leakage is bubble-tight.
End connections	$\frac{1}{4}$" to 1" NPT; socket weld or butt weld

Series 427 is but one of many Valcor series suitable for nuclear service.

High Pressure/Flow



Series 387 Designed for high-pressure, high-flow pneumatic service over a temperature range of −65°F to +500°F. Coaxial type. We believe this valve series offers the lowest pressure drop of any poppet valve. The unusual bulkhead mount allows the valve to function through vibration up to 20 G and shock loads up to 40 G. The unique valve seat enables the unit to withstand the erosive effect encountered in high pressure, high flow pneumatic systems.

Specifications:

Pressure	100 to 5000 psi
Flow	C_v of 6.9 with —12 port
Burst pressure	12,500 psi
Leakage	4 cc/hr. maximum
Voltage	18-30 V. DC
Current	1.0 amps maximum @ 30 V. DC 70°F
Dielectric	1000 volts RMS minimum

These are just four typical examples from a selection of thousands of solenoid valves available from Valcor . . . every variation for every application from the most creative, most imaginative engineering minds in the industry. Mail this coupon today.

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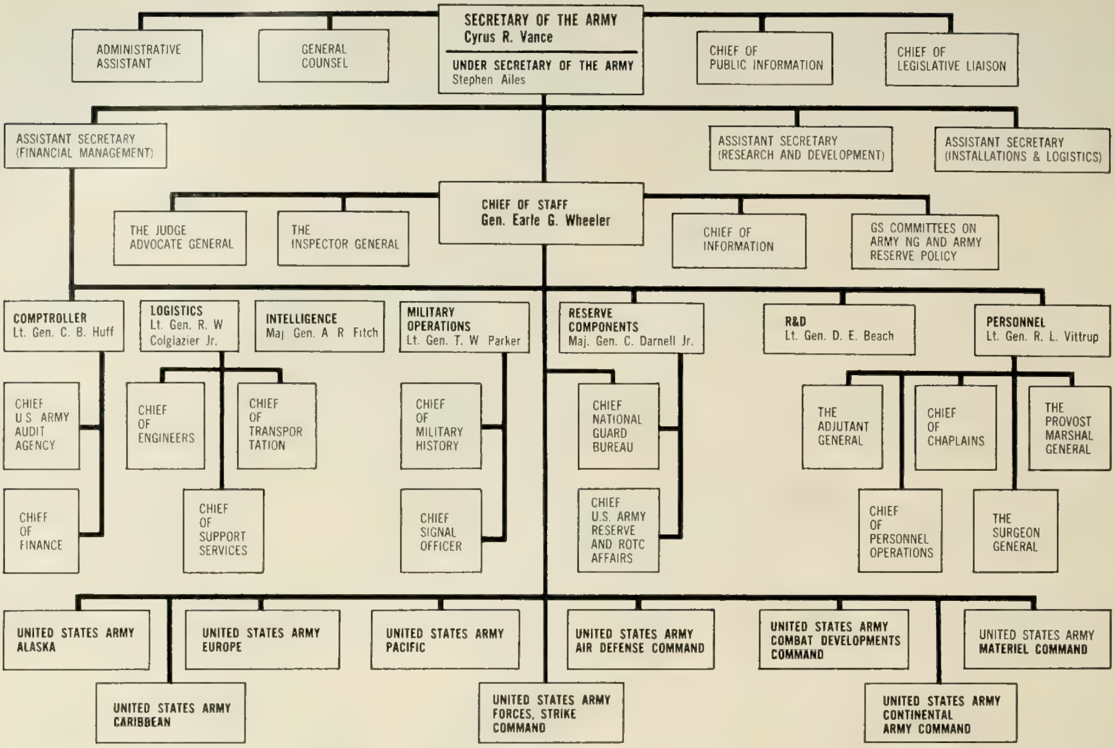
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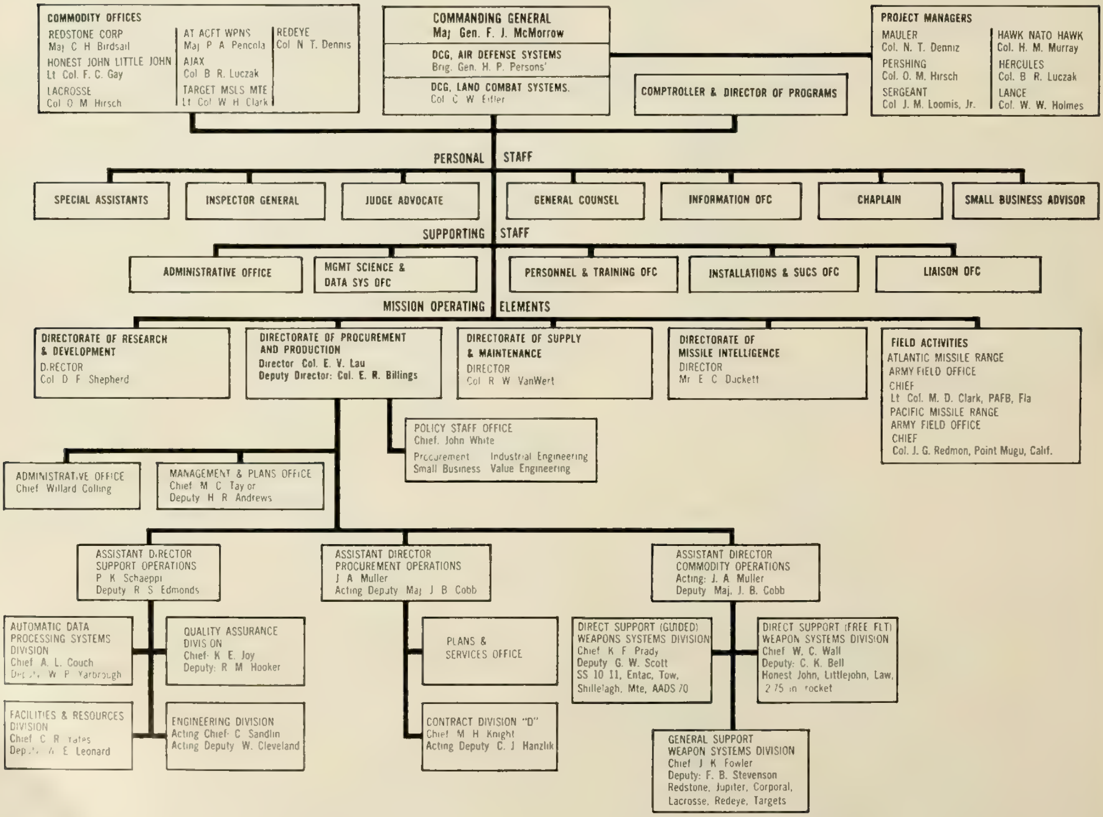

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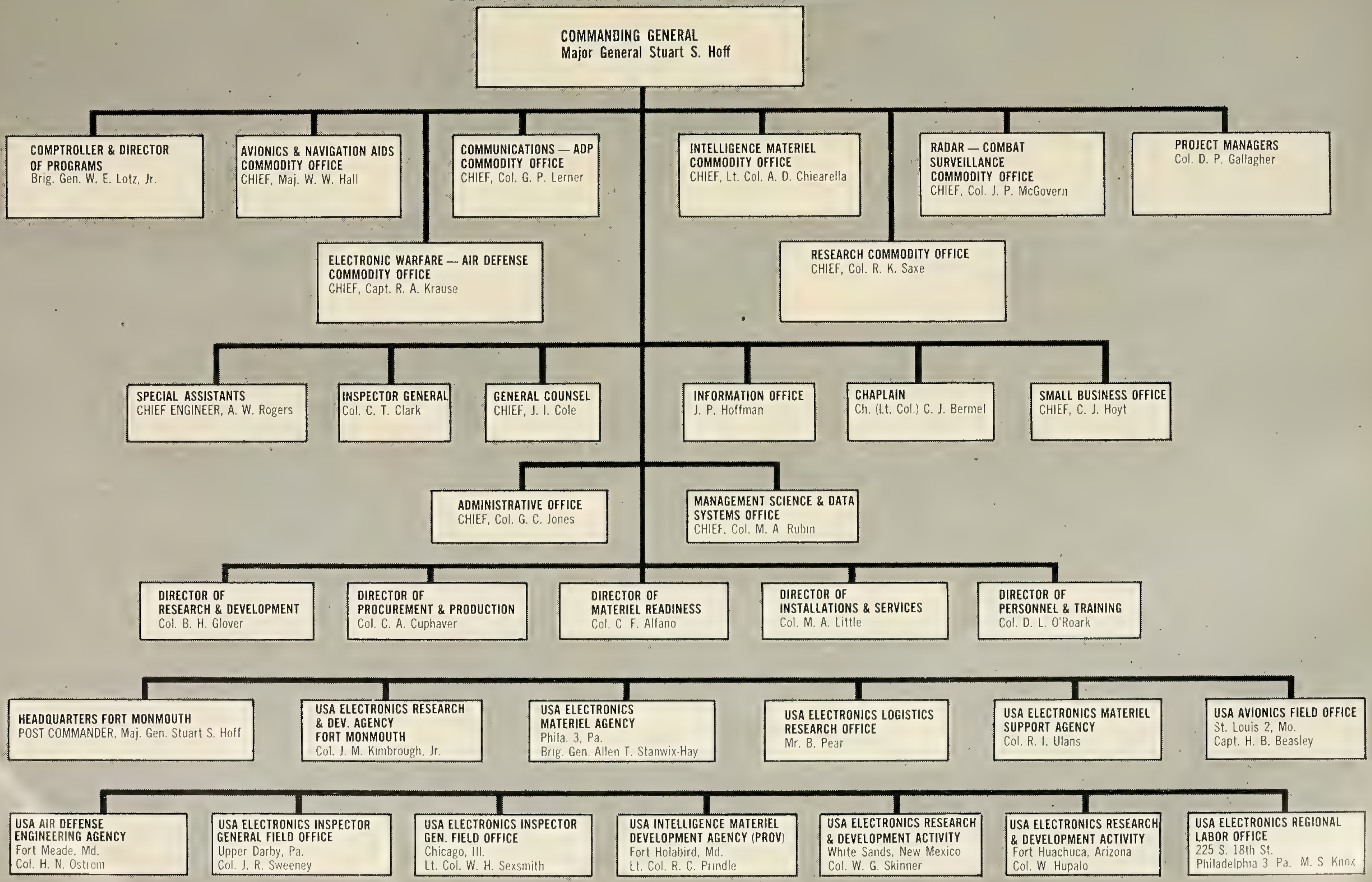
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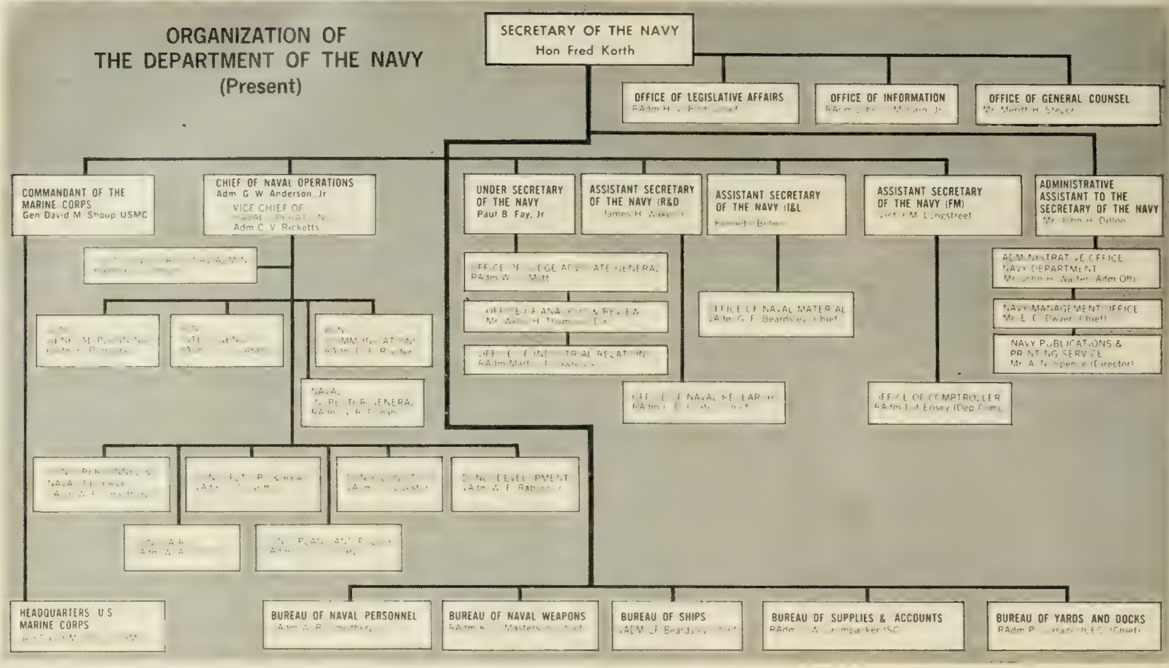
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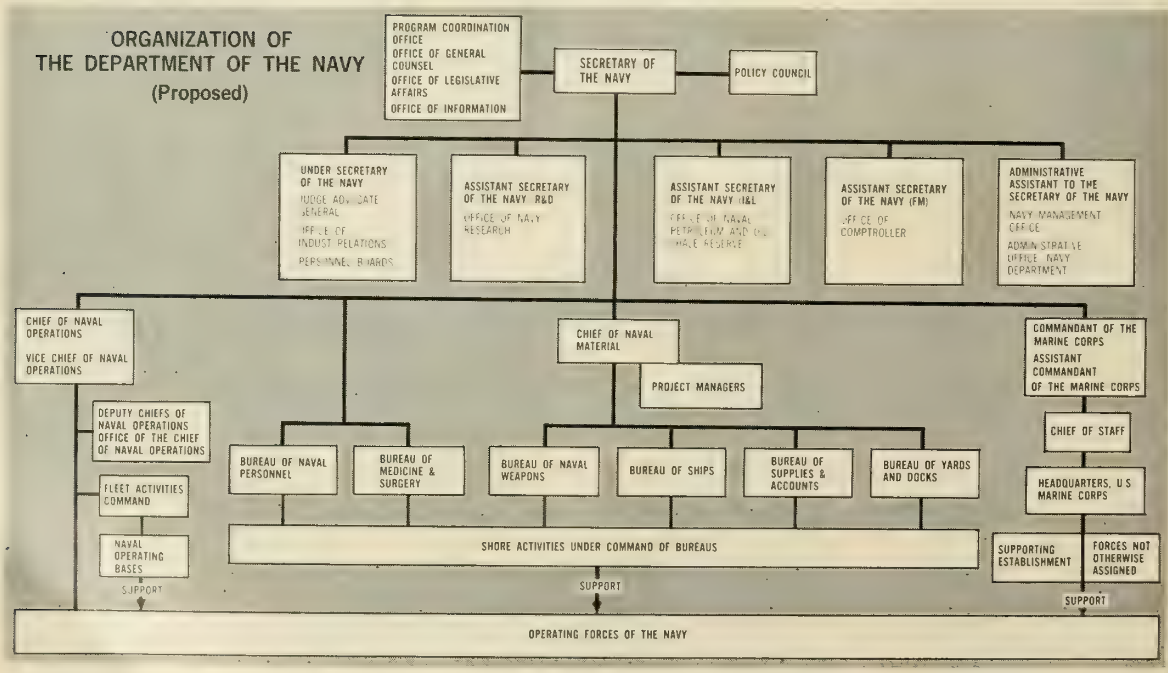
ORGANIZATION OF THE DEPARTMENT OF THE NAVY

(Present)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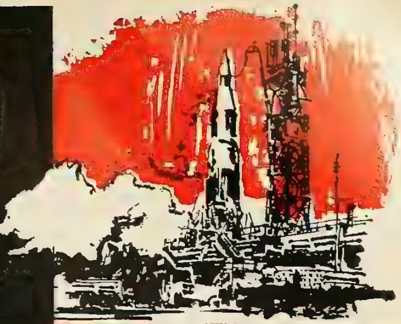
ELECTRO-COMBUSTION DEVICES AND SYSTEMS

for land sea and space applications



hi-shear developed Electro-Combustion Devices serve a dual function. First, they act as high strength fasteners, connectors or as a means of containment. Secondly, on command, the devices are electrically initiated, releasing energies produced by combustion to mechanically push, pull, spin, separate, sever, jettison structure, components or activate other functional systems.

Hi-Shear's controlled energy principle uses a small charge of low pressure type powder to achieve an instantaneous, mechanical action.

Standard electro-combustion hardware designed by Hi-Shear may be used, or the Hi-Shear controlled energy principle may be applied to custom applications you may have as exampled by the release of external stores from aircraft, operation of undersea devices, time delay mechanisms, missile tie-down in silo, stage separation or for a variety of applications on space vehicles.

CAPABILITIES A combination of Hi-Shear capabilities are offered: electronic and ordnance talents of an experienced staff; design, manufacturing and quality control skills as a long established precision hardware manufacturer; as well as complete laboratory facilities for ordnance, metallurgical, physical and environmental testing and instrumentation.

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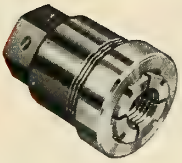
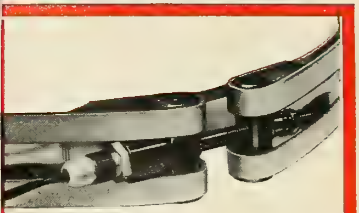
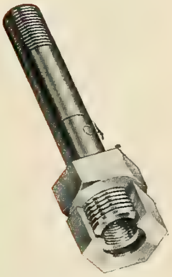


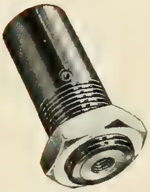
SEPARATION NUT
For joint separation, this Nut can be used in combination with a standard diameter, high strength bolt at its full design allowable. Captive and non-captive configurations available.



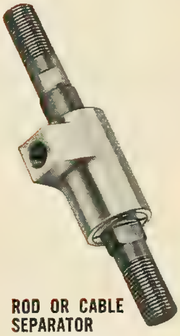
CLAMP SEPARATOR
Provides instant release of ring or circular type clamp. Also imparts a separation impulse to the clamp or band itself to free the latter from the structure. Will carry full tensile loads of MS bolts.



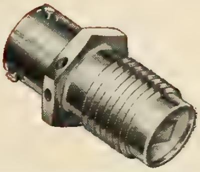
SHEAR BOLT
Fabricated to standard diameter sizes, Hi-Shear's bolt fails a shear pin to produce a controlled, non-fragmenting separation.



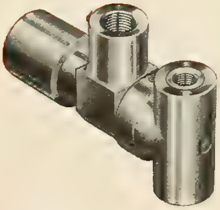
THRUSTER
Functions as a mechanical fastener until commanded to separate and then imparts its energy to direct separation of structure or component. is controllable to desired velocity and distance.



ROD OR CABLE SEPARATOR
Used to separate a rod or cable under tension. Eliminates need for guillotine mechanism or fracture ring method. Capable of carrying full tensile allowables of the rod or cable.



POWER CARTRIDGES
Provides combustion energies for the initiation of mechanisms for separation or ejection systems as well as explosively actuated components. Is certified to comply with AFMTC Ordnance Standards, 1 amp, 1 watt, no-fire, for Radiation Hazards.



PIN PULLER
Allows release of pin or rod without need to sever or fragment high tensile strength material.

hi-shear
CORPORATION
2600 WEST 247TH STREET • TORRANCE • CALIFORNIA

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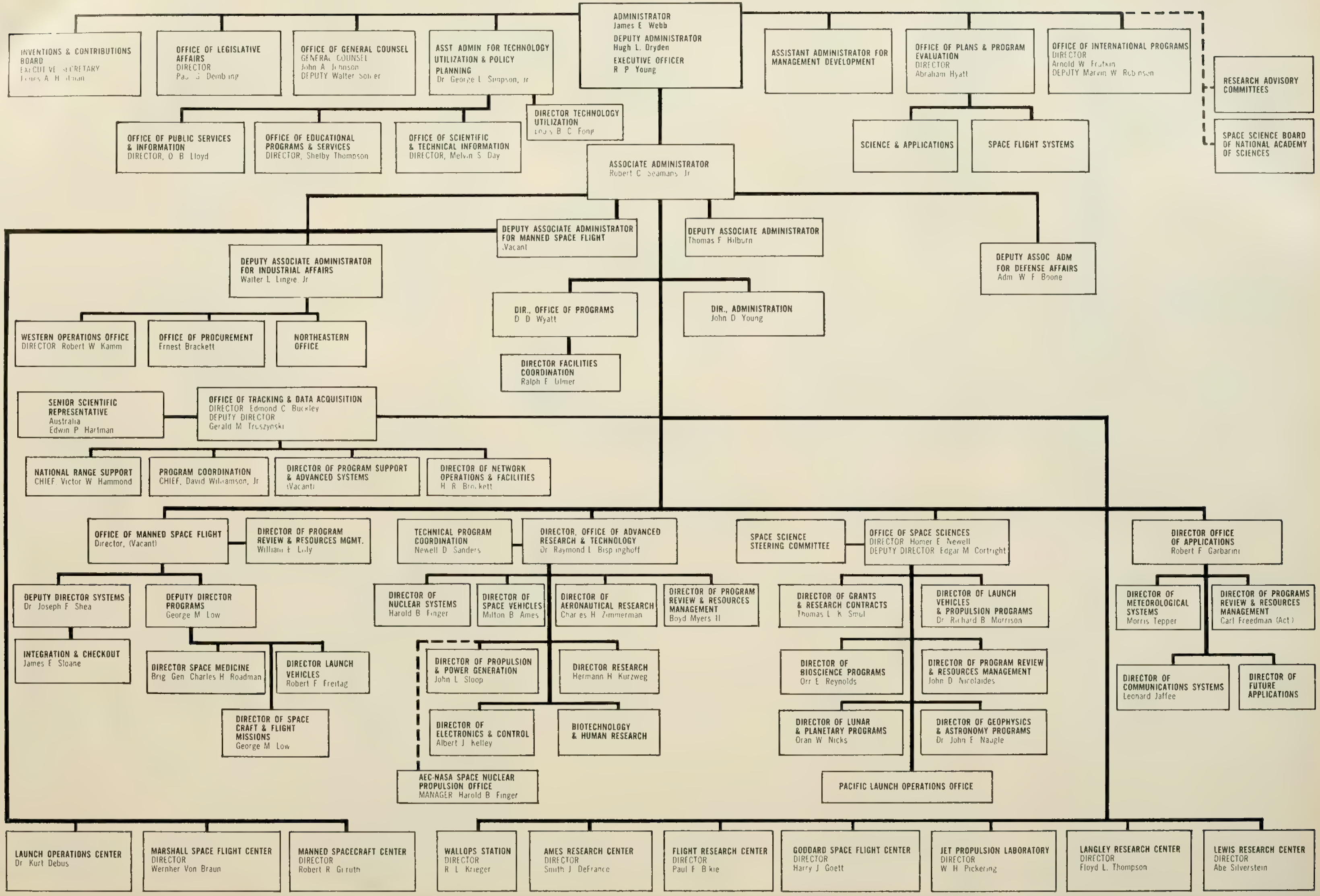
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION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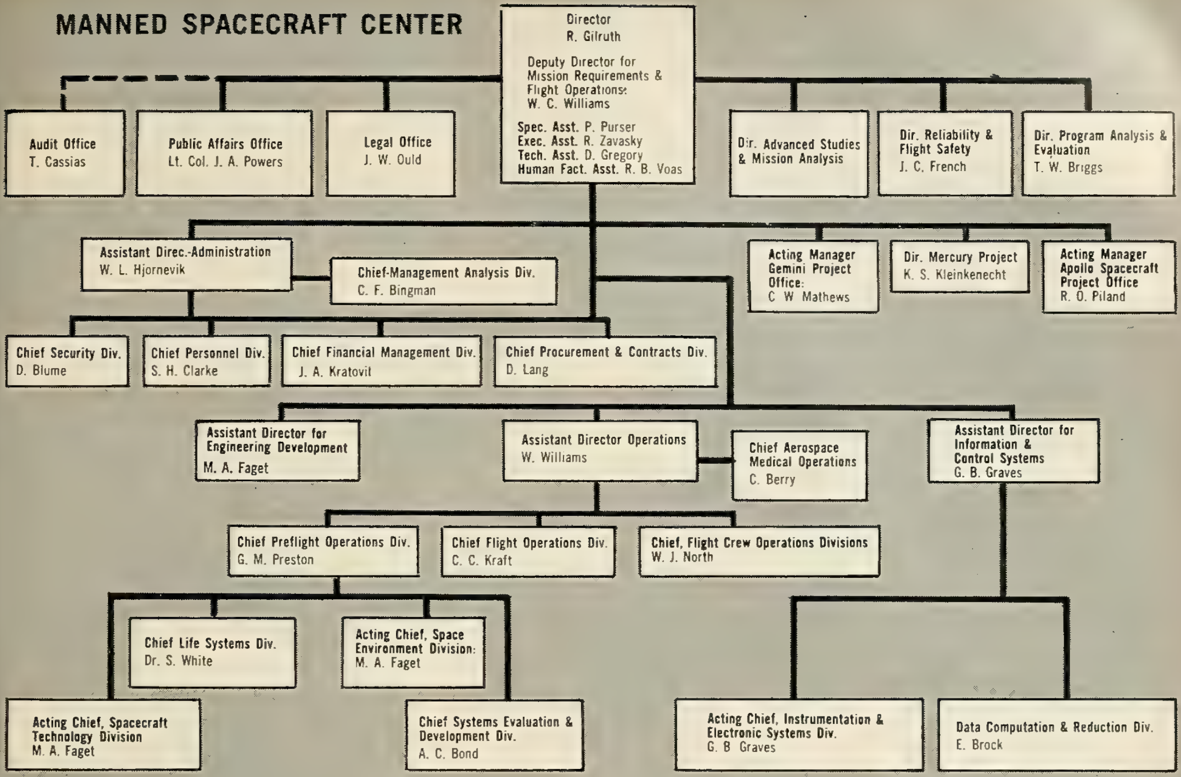
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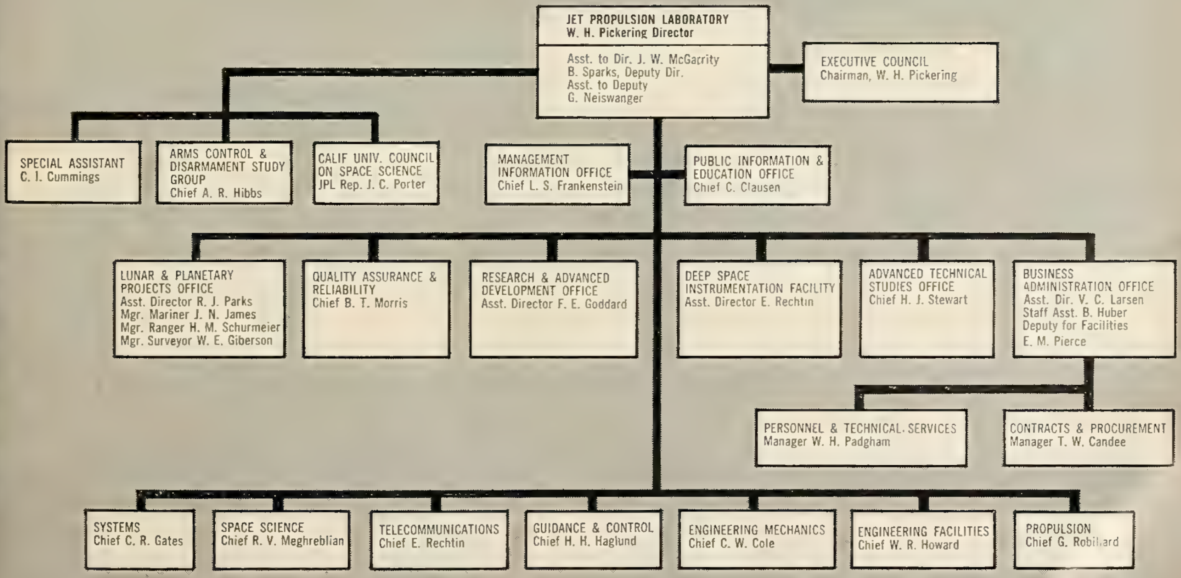

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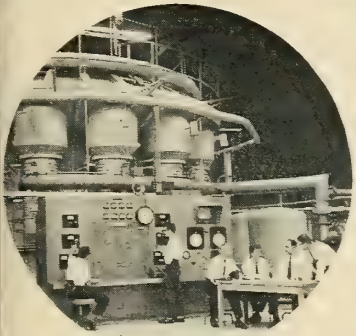
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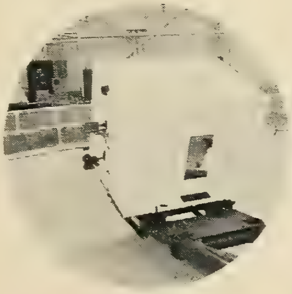
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An estimated 65% of the total effort invested in aerospace development is in the area of ground and flight testing. At Grumman, the formidable challenge of the unknowns of space necessitated the design and construction of suitable, often original, equipment and facilities for aerospace test.

Among the facilities available for pre-flight qualitative and quantitative evaluation of satellite systems are:

- The Space Vehicle Simulator for evaluation of lunar landing and docking techniques.
- The Environmental Test Vacuum Chamber containing an air-bearing table which, with surrounding Helmholtz coils, permits simulation of the magnetic environment of space.
- The Space Thermal Vacuum Chamber for thermal evaluation.
- The Centrifuge for sustained acceleration testing of space vehicles and components.

In brief, Grumman's advanced test facilities are an excellent augury for both the continued development of the company and the engineers who have them at their disposal.

Engineers and scientists who feel that up-to-the-minute facilities are a necessary adjunct to their own professional development are urged to investigate the following immediate positions:

Temperature Control Engineers—BS or MS and 2 years experience to handle space vehicle temperature control system analysis. Should have background in radiative heat exchange and thermal coatings as applied to passive and active temperature control systems.

Fluid Mechanics Engineers/Internal Aerodynamicists—BS or MS with a minimum of 2 years experience applicable to analysis and test work on Reaction Jet Control Systems, Nozzle Design, Inlets, Jet Exhausts, Gas Bearings, Pressurization Systems, Thrust Vector Control, VTOL Internal Flow and Airborne Cooling Systems.

Rocket Propulsion Engineers—Engineering degree plus several years of direct experience in the analysis, design, development, or testing of liquid rockets. Duties will involve analysis and development of propulsion systems for manned space vehicle. Special experience in propellant flow analysis, reaction control rockets, or IBM programming is desirable. Both junior and senior positions available.

Aerospace Environmental Control & Life Support Systems Engineers—BS in ME, Chemical Eng., or EE, with a minimum of 2 years fluid mechanics and/or thermodynamics experience in analysis, design, development, testing, installation for aircraft and space vehicles in one or more of the following areas ENVIRONMENTAL CONTROL (Cabin, Equipment, Pressure Suit-cooling, heating, pressure, humidity, controls); LIFE SUPPORT (Stored, Regenerative, Ecological Systems-CO_2, toxic gases, odor and moisture removal); CRYOGENICS (Storage, Supply, Temperature and Pressure Controls); TESTING (Development, Qualification, Functional Pre-flight).

To arrange an immediate interview, SEND RESUME to Mr. P. M. Van Putten, Manager Engineering Employment, Dept. GR-86

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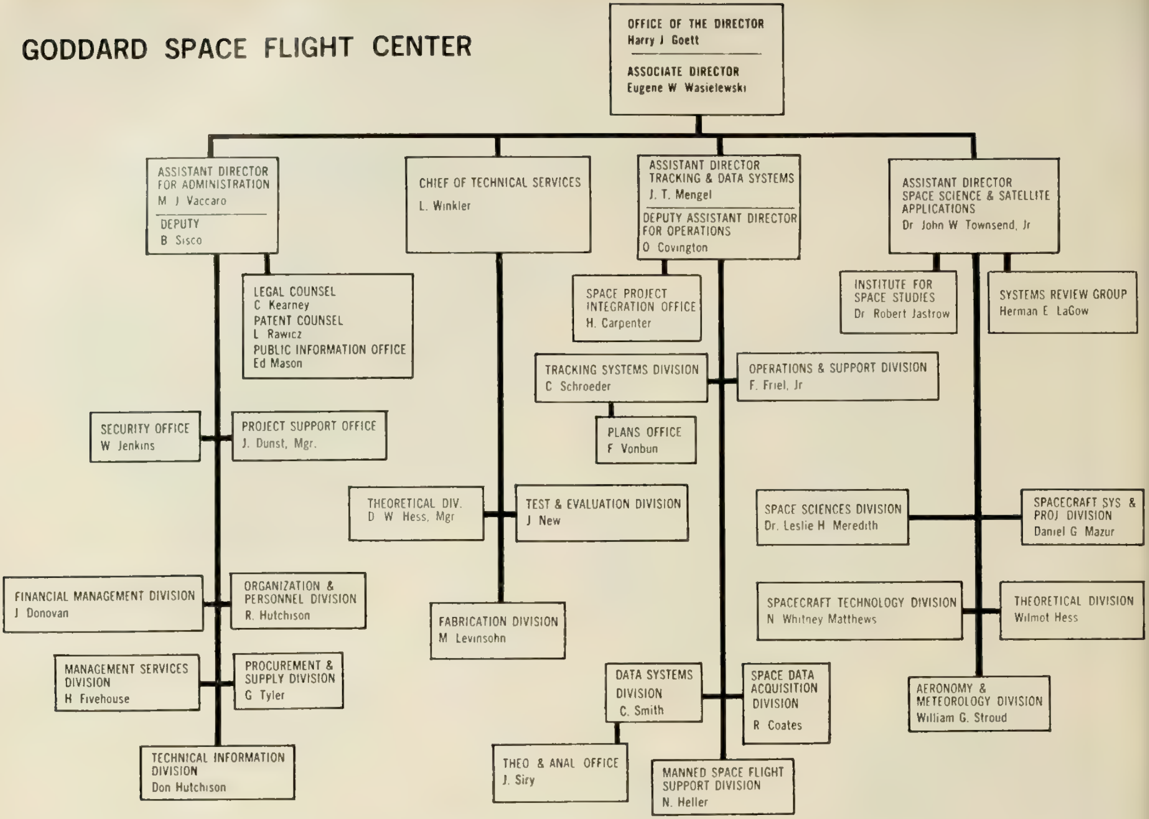

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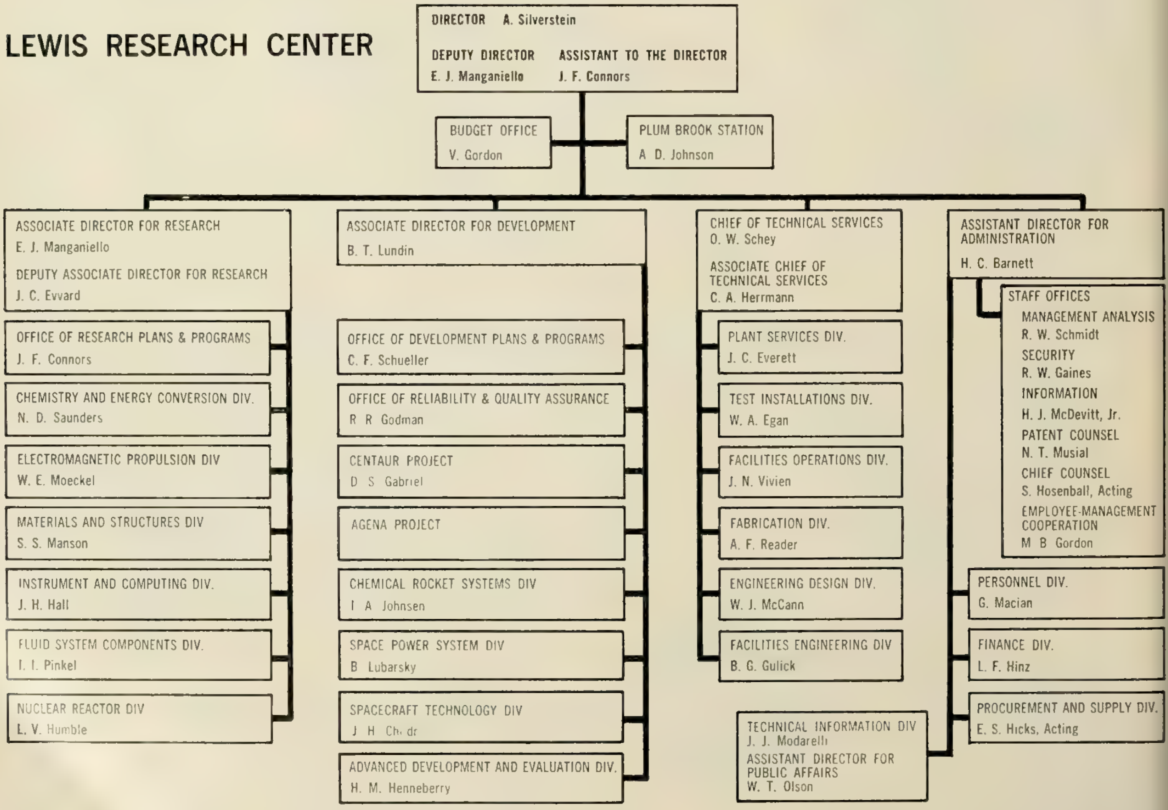

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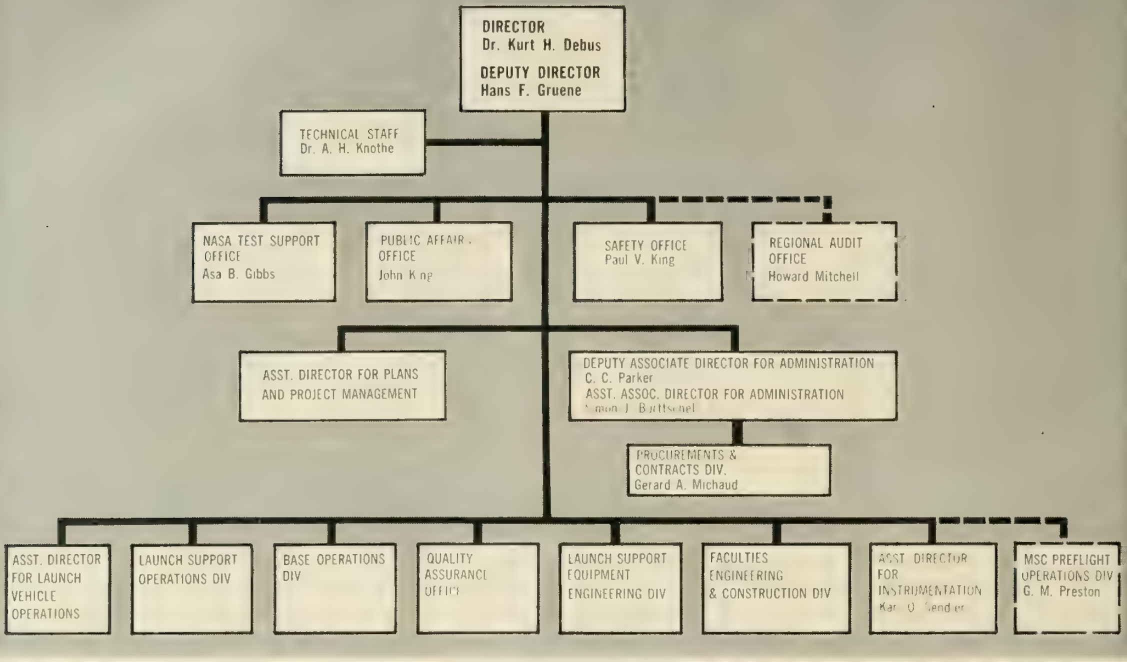
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Roaring out of the exit cone at Mach 3 and a temperature over 3,000 degrees F, the big flame must be tamed and directed; an engineering challenge of the first magnitude.

This crucial program is of more than usual interest to scientists and engineers concerned with growth and development. For it means this young, fast-growing company is now in position to provide even more in the way of ground-floor openings.

SCIENTISTS AND ENGINEERS: We know our best years are ahead of *us*—just as your best years are ahead of *you*. Therefore, we invite you to explore openings in: Operations Analysis; Propulsion Analysis; Visco-elasticity; Design Engineering; Proposal Engineering; Project

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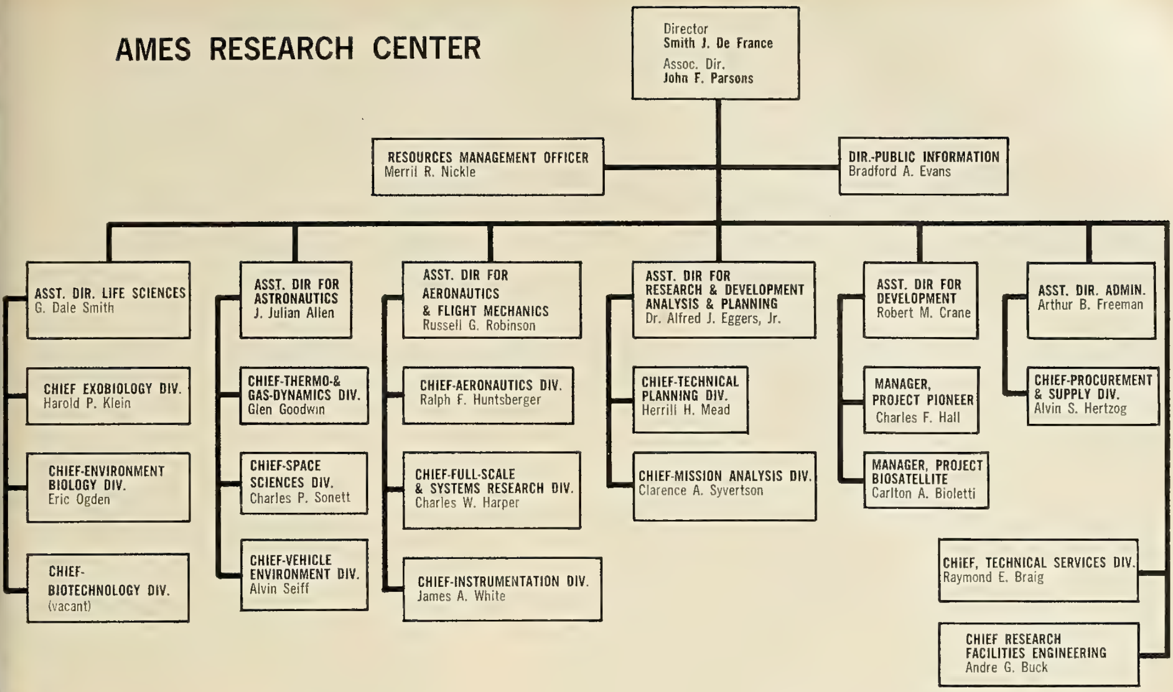
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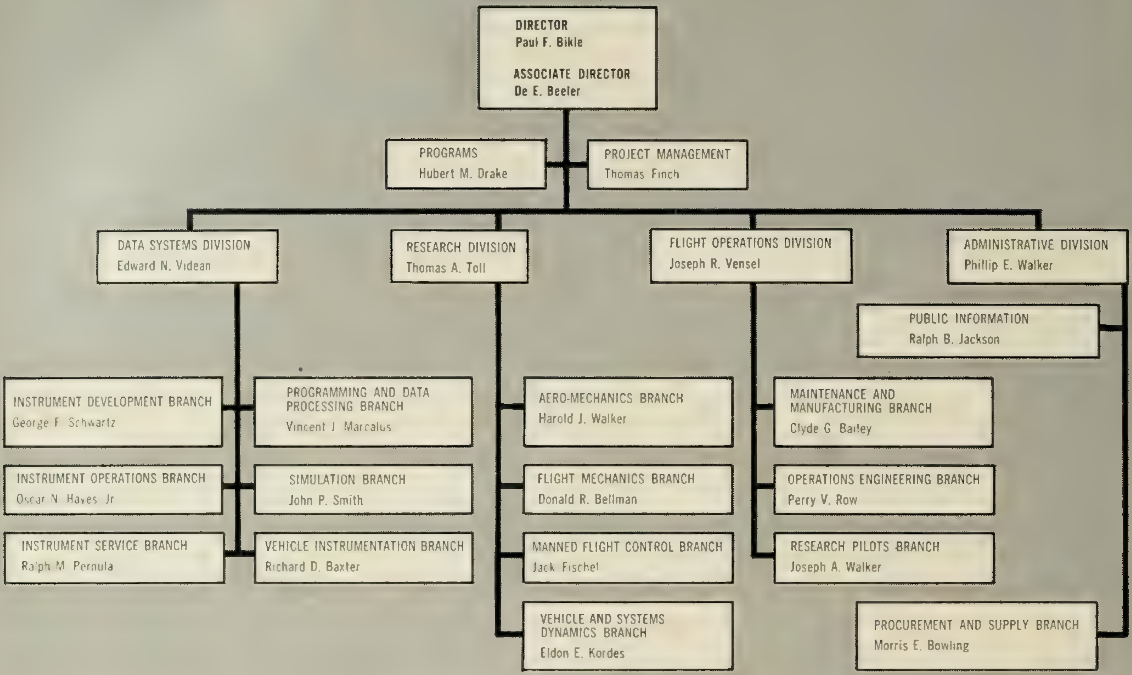

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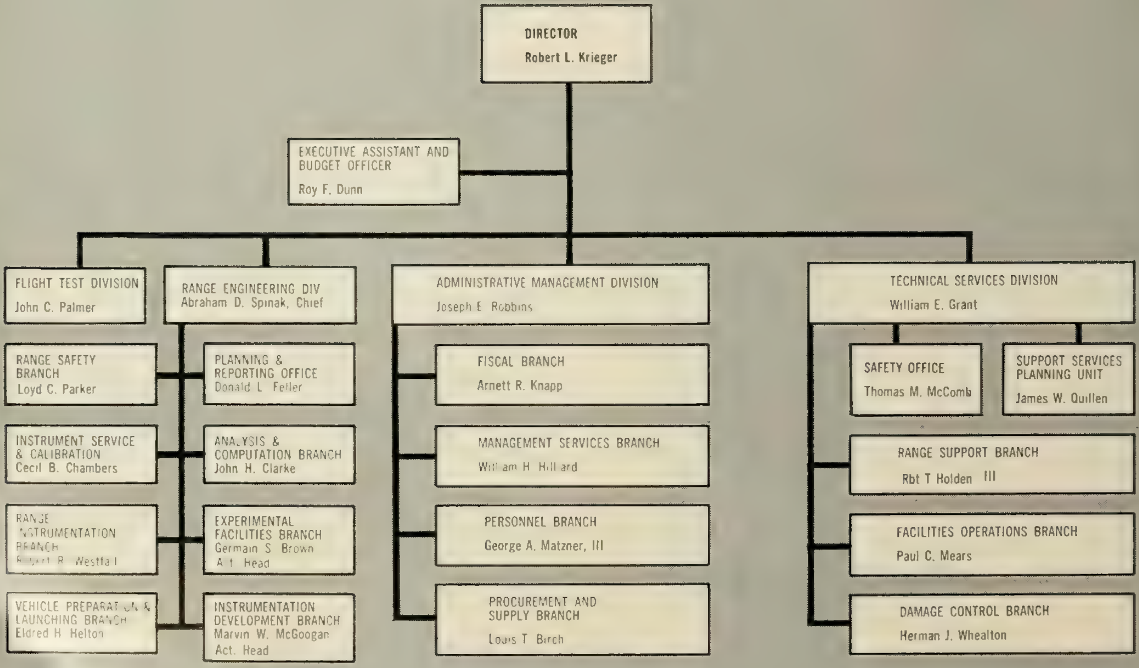

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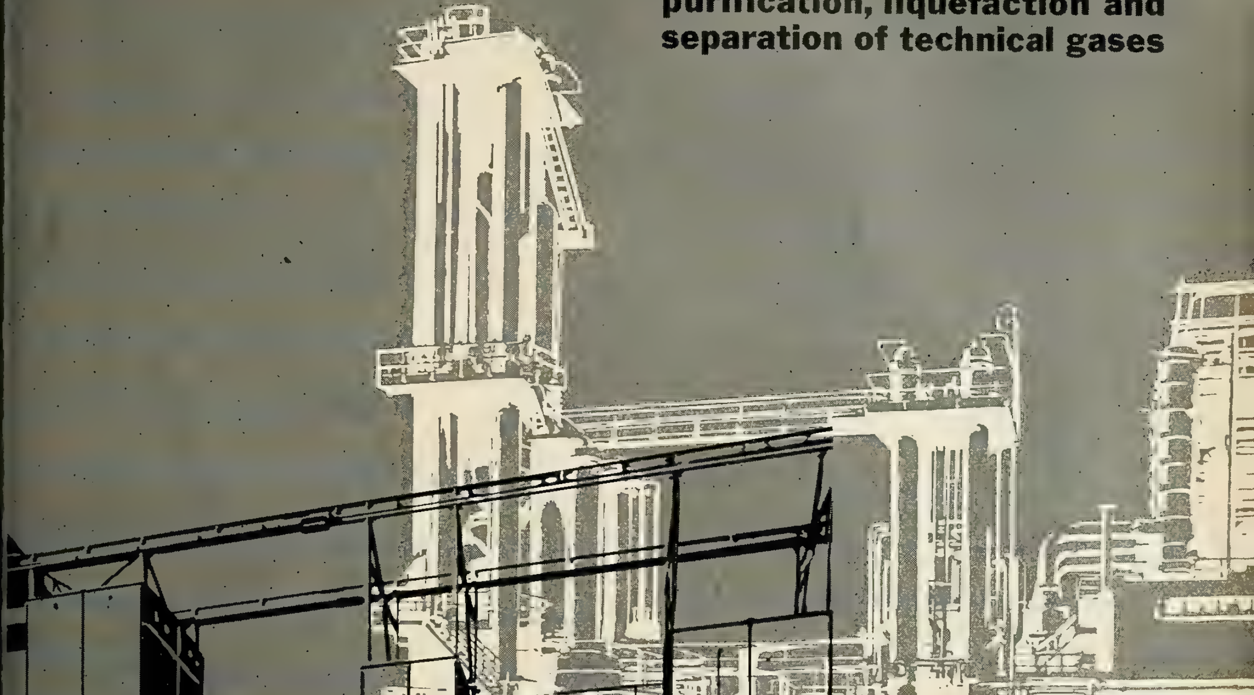

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House Action on FY 1964 Budget Requests

Department of Defense Appropriations (Thousands of Dollars)

MILITARY PERSONNEL

TOTAL—MILITARY PERSONNEL	12,848,200

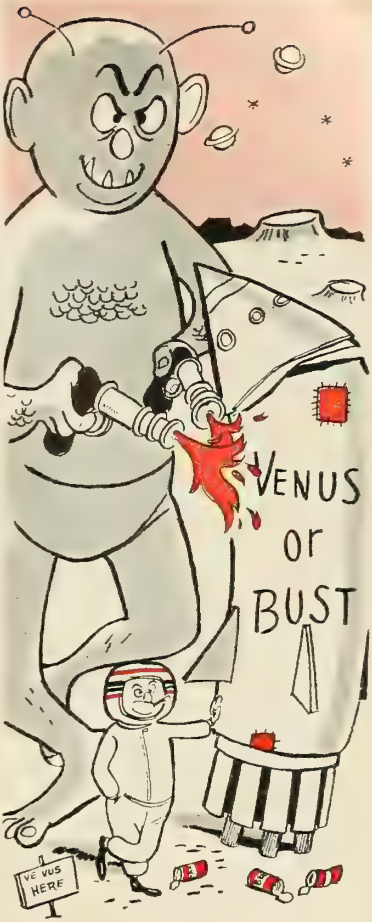
OPERATION AND MAINTENANCE

Operation and Maintenance, Army	3,361,000
Maintenance of non-combat vehicles	
Overseas dependents education	
Mapping and geodesy	
Field exercises	
NATO status of forces support	
M-14 rifle models	
Real estate administration	
Minor O&M reductions not specified	
Operation and Maintenance, Navy	2,905,000
Surface missiles and equipment rework	
Logistic support programs	
Inspection and supporting programs	
General use forms	
Commissary stores	
Departmental administration—personnel compensation	
Technical publications	
Deepfreeze operation	
Minor O&M reductions not specified	
Operation and Maintenance, Marine Corps	191,000
Minor O&M reductions not specified	
Operation and Maintenance, Air Force	4,341,000
Maintenance of non-combat vehicles	
Command administration	
Training film production	
Alaska Communication System	
Community relations	
Minor O&M reductions not specified	
Operation and Maintenance, Defense Agencies	446,000
Defense Supply Agency	
Secretary's Office	
Armed Forces Information and Education	
Minor O&M reductions not specified	
Operation and Maintenance, Army National Guard	176,600
Operation and Maintenance, Air National Guard	222,700
National Board for the Promotion of Rifle Practice, Army	528
Claims, Defense	19,000
Contingencies, Defense	15,000
Court of Military Appeals, Defense	509
TOTAL—OPERATION AND MAINTENANCE	11,678,337

PROCUREMENT

Procurement of Equipment and Missiles, Army Aircraft, Missiles and Naval Vessels	2,958,894
Authorization Act (PL 88-28):	
Aircraft	
Missiles	
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
MAULER	
Fixed-wing primary trainer aircraft	
Instrument trainer helicopters	
UH-1B/C IROQUOIS	
Aircraft spare parts	
Missile spare parts	
¾-ton trucks	
Machine tools and industrial facilities	
Production engineering measures	
Additional "free assets"	
Electronics and telecommunications equipment	
Radio set, AN/PRC-25	
Procurement of Aircraft and Missiles, Navy Aircraft, Missiles and Naval Vessels	2,877,445
Authorization Act (PL 88-28):	
Aircraft	
Missiles	
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
EA6A INTRUDER	
A5C VIGILANTE ground trainer	
RF4B PHANTOM	
E2A HAWKEYE	
S2E TRACKER spare parts	
U-8F trainer	
T-2B trainer	
TC-4B GULFSTREAM trainer	
Aircraft component improvements	
Aircraft industrial facilities	
Missile industrial facilities	
Aircraft production charges	
TYPHON	
Additional recoupments	

Shipbuilding and Conversion, Navy Aircraft, Missiles and Naval Vessels	2,080,089
Authorization Act (PL 88–28)	
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
Labor and materiel costs (ships)	
SEA MAULER	
Roll-on/Roll-off cargo and vehicle ships	
New LST type vessel	
Other Procurement, Navy	1,175,231
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
Electronics and telecommunications equipment	
Passenger-carrying motor vehicles	
Mobile equipment in support of ship operations	
Production facilities for weapons and support equipment	
Aircraft support shop equipment	
Procurement, Marine Corps	201,960
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
Digital data computers	
Aircraft Procurement, Air Force Aircraft, Missiles and Naval Vessels	3,328,900
Authorization Act (PL 88–28)	
Improved contractual methods and procedures, and more responsible competitive procurement (1%)	
Additional recoupments	
C–141 Jet transport ($10,000 for spare parts)	
RF–4C PHANTOM II ($5,000 for spare parts)	
Logistic support aircraft (XH–48A and HCH–48B helicopters)	
HC–130E search and rescue	
Aircraft component improvements	
Aircraft industrial facilities	
Missile Procurement, Air Force	2,129,490
Improved contractual methods and procedures and more responsible competitive procurement (1%)	
Additional "free assets" and recoupments	
Missile industrial facilities	
Other Procurement, Air Force	871,299
Improved contractual methods and procedures and more responsible competitive procurement (1%)	
Additional "free assets" and recoupments	
MMB–1 fuse	
Electronics and telecommunications equipment (including $2,000 for modifications and $500 for industrial facilities)	
Vehicular equipment and spare parts	
Base maintenance equipment	
Supplies and materials	
Procurement, Defense Agencies	43,164
Improved contractual methods and procedures and more responsible competitive procurement (1%)	
TOTAL—PROCUREMENT	15,666,472



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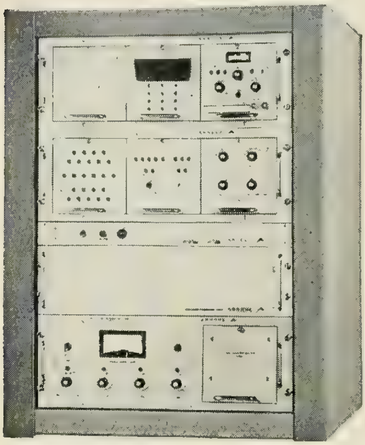

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Because of these unique advantages:

- Bit rate from 1 cps to 1 mc
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RESEARCH, DEVELOPMENT, TEST AND EVALUATION

Research, Development, Test, and Evaluation, Army Aircraft, Missiles and Naval Vessels	1,363,141
Authorization Act (PL -88-28)	
General reduction in "Other" programs (3%)	
Application of FY 1963 ADVENT funds	
LANCE missile system	
Research, Development, Test, and Evaluation, Navy Aircraft, Missiles and Naval Vessels	1,525,713
Authorization Act (PL 88-28)	
General reduction in "Other" programs (3%)	
Research, Development, Test, and Evaluation, Air Force Aircraft, Missiles and Naval Vessels	3,416,146
Authorization Act (PL 88-28)	
General reduction in "Other" programs (3%)	
Mobile mid-range ballistic missile (MMRBM)	
Research, Development, Test, and Evaluation, Defense Agencies	434,000
General reduction in "Other" programs (3%)	
Emergency Fund, Defense	[a]150,000
TOTAL—RESEARCH, DEVELOPMENT, TEST AND EVALUATION	6,889,000
TOTAL—ALL ITEMS	47,082,009

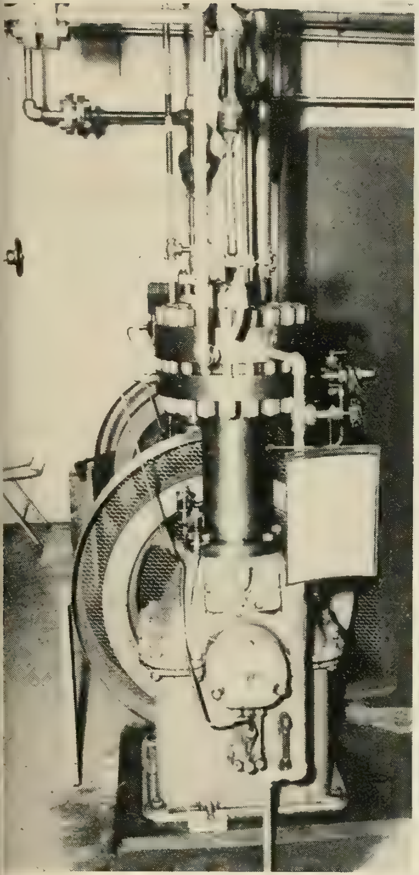
RECAPITULATION

Department of the Army	12,095,563
Department of the Navy	14,369,838
Department of the Air Force	18,365,935
Defense Agencies/OSD	2,250,673

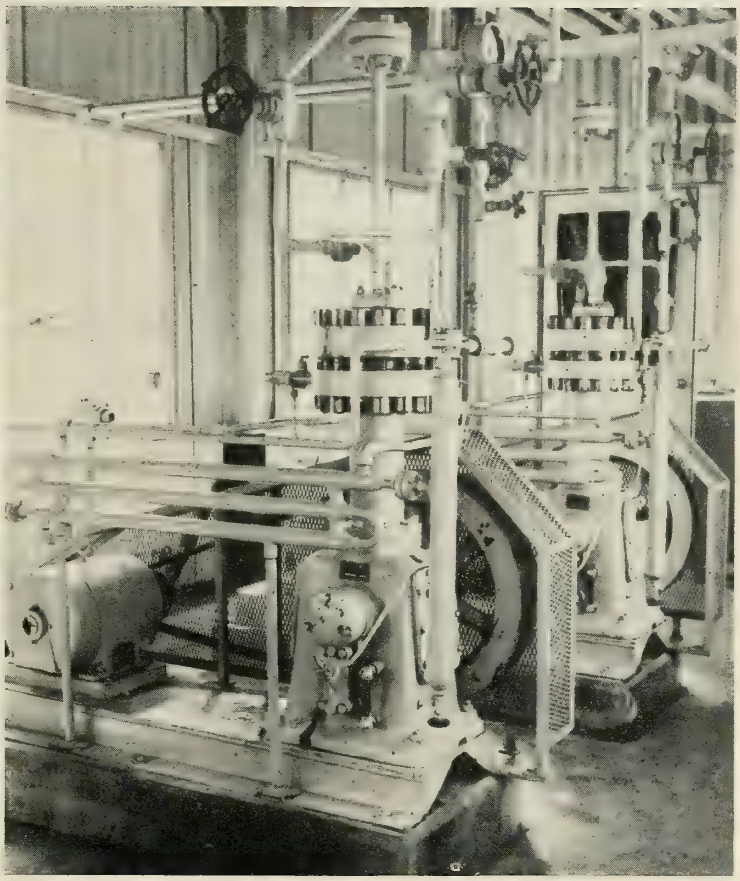
[a] In addition, $350,000,000 to be derived by transfer from other appropriations available for obligation in FY 1964: $150,000,000 for regular Emergency Fund purposes and $200,000,000 for other purposes vital to the security of the United States.

Absolute Leak-Free, Contamination-Free Operation

CORBLIN DIAPHRAGM-TYPE COMPRESSORS



Above left: The Nevada Test Site of the A.E.C., operated by the Los Alamos Scientific Laboratory, uses a total of 10 Corblin Compressors to transfer hydrogen and helium from railroad and truck transport vessels . . . and to pump gas into storage vessels at pressures up to 3,600 p.s.i.



Above right: In their helium-producing plants in Texas and Oklahoma, the U.S. BUREAU OF MINES utilizes eight Corblin Compressors to pressurize railroad and truck transport tanks containing helium for shipment at pressures in excess of 2,200 p.s.i. (plant operating pressure). The compressors are single-stage machines capable of discharging at pressures up to 5,000 p.s.i.

For Compressing and Transferring Helium, Hydrogen, Argon, or Other Gases

Corblin compressors are used in above described applications because they operate without contamination of gas undergoing compression and without leakage which is inevitable with other types of compressors. Additionally, compression ratios up to 20 to 1 per stage are practical, permitting suction to be taken directly from a vessel at fluctuating intake pressure. This eliminates any need to pass gas through pressure regulators to fixed low pressure for suction into compressor. As a consequence, smaller and less expensive equipment can be used for transference of given quantities of gas within specified times, than would otherwise be possible. **SEND FOR BULLETIN 4074B** which describes Corblin diaphragm-type compressors for all types of gas . . . capacities to several hundred s.c.f.m., and pressure ratings to 30,000 p.s.i. Corblin diaphragm pumps for all types of liquids are also described.

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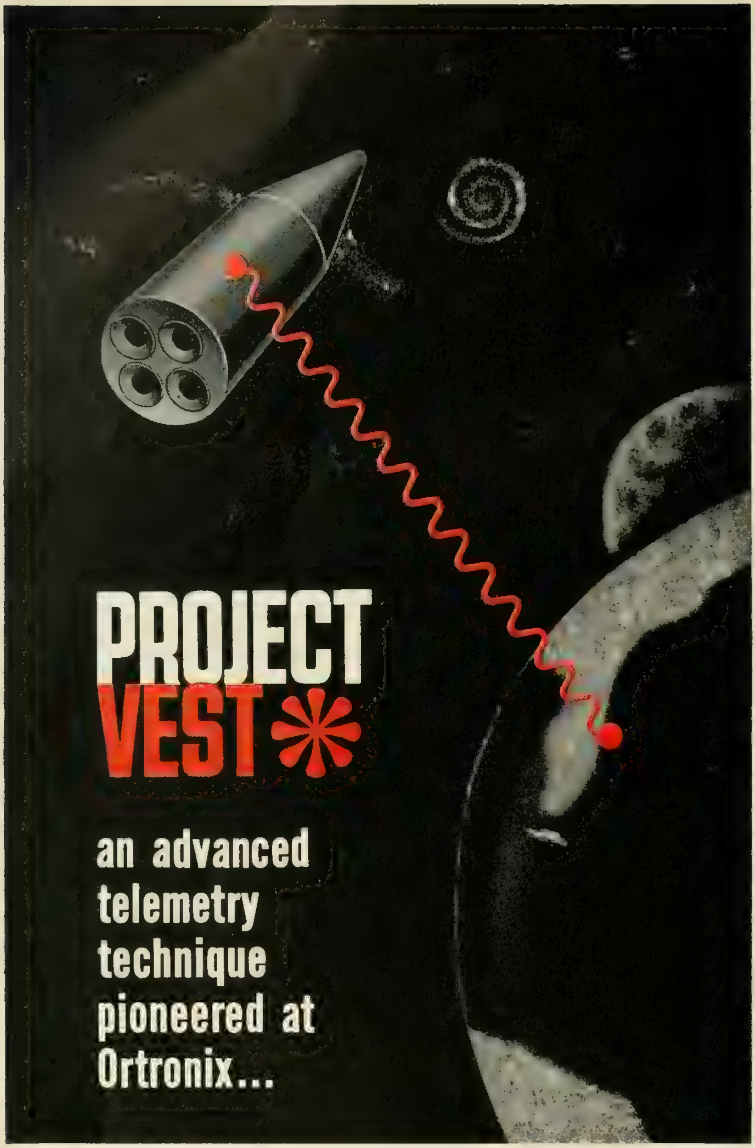
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NASA FY '64 Budget Authorized by House Space Committee (For direct R&D and construction of facilities)

OFFICE OF MANNED SPACE FLIGHT

	FY 1964 (Thousands of Dollars)
MANNED SPACECRAFT SYSTEMS	
Spacecraft supporting technology	21,100
Gemini	
Spacecraft	196,200
Operations	14,600
Launch vehicles	94,800
Supporting development	700
Apollo	1,080,000
Misson control-center operations	21,800
LAUNCH VEHICLES & PROPULSION	
Launch vehicle SR&T	16,900
Propulsion SR&T	22,500
Launch operations SR&T	7,600
Saturn I (Saturn)	
S–1 stage	26,500
S–IV stage	25,500
Vehicle instrument unit	3,000
Guidance systems	2,000
H–1 engine (procurement)	2,800
RL–10 engine (procurement)	3,400
System integration	30,600
Saturn IB (Saturn B)	
S–I stage	13,500
S–IV stage	19,100
Vehicle instrument unit	6,000
Guidance system	5,200
H–1 engine (procurement)	3,700
J–2 engine (procurement)	4,200
Systems integration	16,900
Saturn V (Advanced Saturn)	
S–IC stage	291,600
S–II stage	181,400
S–IVB stage	82,300
Vehicle instrument unit	17,000
Guidance system	16,000
F–1 engine (procurement)	53,100
J–2 engine (procurement)	16,600
Support	75,000
M–1 engine	15,000
H–1 engine	5,200
RL–10 engine	32,600
F–1 engine	54,100
J–2 engine	48,200
Range instrumentation	20,000
Range support	21,000
AEROSPACE MEDICINE	
Research and development	11,000

INTEGRATION & CHECKOUT

Research and development	125,000

SYSTEMS ENGINEERING

General mission support	12,700
Engineering and studies	2,000
Advanced studies	11,300
Lunar logistics system studies	6,000
Nova study	5,000
TOTAL AUTHORIZED	2,740,700

OFFICE OF APPLICATIONS

METEOROLOGICAL SATELLITES

Supporting Research and Technology	
Synchronous meteorological satellite	950
Advanced meteor. sensor development	3,200
Meteor. systems research	2,450
Advanced meteor, system component development	3,600
Flight Programs	
Tiros	7,200
Nimbus	43,800
Sounding rockets	2,500

COMMUNICATIONS SATELLITES

Supporting Research and Technology	3,075
Flight Programs	
Echo	200
Relay	1,900
Syncom	4,000
Advanced Synchronous Communications Satellites	33,000

OTHER APPLICATIONS

Advanced applications satellites	1,000
Industrial applications	3,500
TOTAL AUTHORIZED	110,375

OFFICE OF SPACE SCIENCES

GEOPHYSICS & ASTRONOMY

Supporting Research and Technology	
Geophysics	9,500
Solar Physics	2,000
Astronomy	3,000
Interdisciplinary Space Sciences	700
Flight Projects	
Geophysics	88,600
Solar Physics	17,400
Astronomy	52,900

(Continued on page 184)

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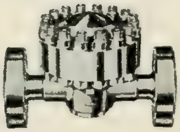

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BUDGETS

(Continued on page 183)

International Satellites	3,000
Sounding Rockets & Geoprobes	13,300

LUNAR & PLANETARY EXPLORATION

Supporting Research and Technology	
Lunar	3,895
Planetary and Interplanetary	16,105
Flight Projects	
Ranger	65,000
Surveyor Lander	69,300
Mariner	85,100
Pioneer	15,000

BIOSCIENCE

TOTAL (DIRECT R&D COSTS)	21,200

LAUNCH VEHICLE DEVELOPMENT

Supporting Research and Technology	2,000
Centaur Development	110,700
Operational Support	15,000

FACILITY, TRAINING & RESEARCH GRANTS

Facilities Grants	18,000
Training Grants	25,000
Research Grants	12,000
TOTAL AUTHORIZED	648,700

OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

SPACE VEHICLE SYSTEMS

Supporting research and technology	37,762
Flight projects	
Scout re-entry heating	1,000
Fire	4,000
Scout-launched meteoroid satellites	950
Saturn-launched meteoroid satellites	4,250
Space vehicle recovery	950
Other experiments	4,050

ELECTRONICS SYSTEMS

Guidance systems	5,820
Control systems	4,928
Communication systems	4,585
Tracking and data acquisition	3,488
Instrumentation	4,252
Data handling	3,539
Small flight projects	3,750

HUMAN FACTOR SYSTEMS

Supporting research and technology	13,200

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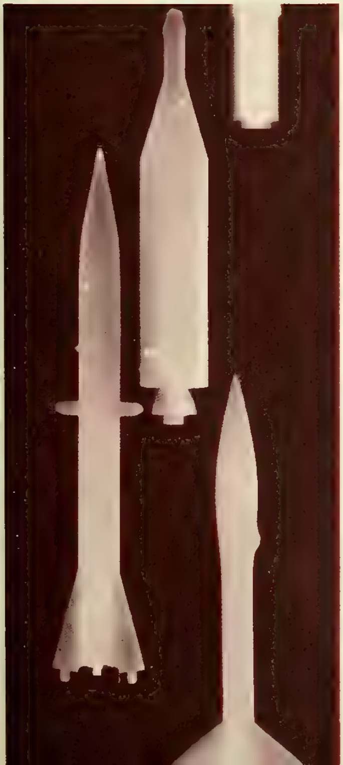

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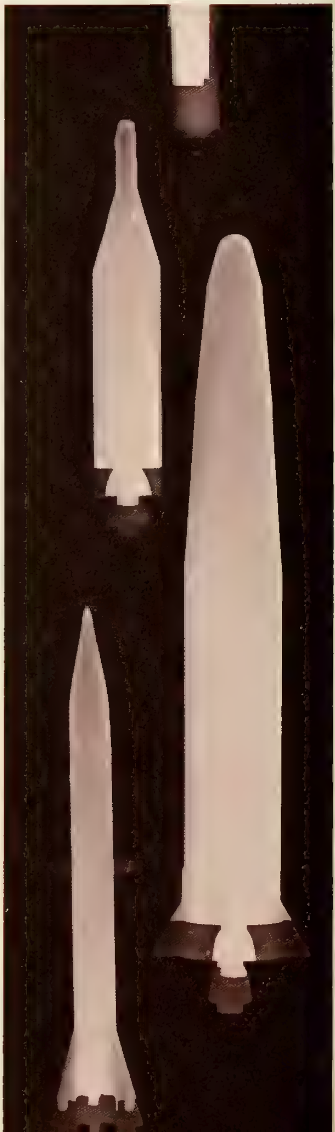
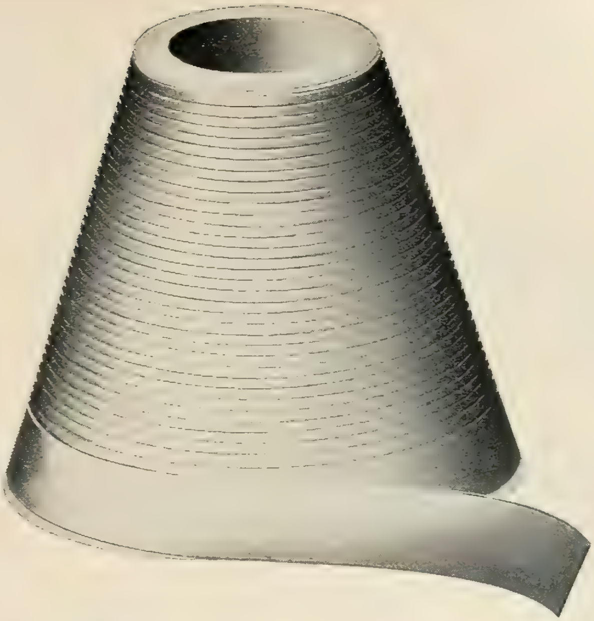


(Continued from page 184)

NUCLEAR-ELECTRIC SYSTEMS	
Supporting research and technology	
Nuclear-electric power	12,132
Electric propulsion	6,886
Development and flight projects	
SNAP-8 development	15,000
SNAP-8 flight evaluation	9,000
MECCA	1,400
Electric engine development	8,000
SERT	15,350
NUCLEAR ROCKETS	
Supporting research and technology	
Rocket reactor research	10,187
Nuclear rocket engine systems	11,200
Vehicle technology	800
Safety technology	500
Projects	
KIWI, NERVA, RIFT	68,000
NRDS operations	1,000
CHEMICAL PROPULSION	
Aerothermochemistry, materials, analysis	7,525
High-energy propellants	3,306
Advanced launch vehicle engine technology	4,474
Advanced spacecraft engine technology	5,618
Experimental high-energy engine	1,574
SPACE POWER	
Solar cells	3,350
Thermionic power technology	3,993
Solar engine technology	3,138
Batteries and fuel cells	2,545
Chemical engines	1,868
Thermoelectric, MHD, advanced concepts	1,630
AERONAUTICS	
Supporting research and technology	9,910
Projects	6,290
TOTAL AUTHORIZED	312,700



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Communications network	4,000
Data processing and handling	10,000
TOTAL Requested	**231,500**
TOTAL AUTHORIZED	216,700

CONSTRUCTION OF FACILITIES PROJECTS

Ames Research Center	11,044
Electronics Research Center	3,900
Goddard Space Flight Center	18,100
Instrumentation Ships	80,000
Jet Propulsion Laboratory	2,998
Langley Research Center	8,204
Launch Operations Center	279,677
Lewis Research Center	18,634
Manned Spacecraft Center	35,102
Marshall Space Flight Center	28,980
Michoud Plant	8,688
Mississippi Test Facility	92,696
Nuclear Rocket Development Station	15,650
Other Facilities	
F-1 engine program	14,238
H-1 engine production	1,410
J-2 engine program	6,900
M-1 engine program	10,000
S-IVB stage program	5,105
RL-10-A-3 engine test	500
Lunar excursion module test	11,500
Telemetry station—Bermuda	600
Meteorological Laboratory	3,933
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COMMUNICATIONS ENGINEER—Work will involve integration of wire, SSB/HF and UHF communications.

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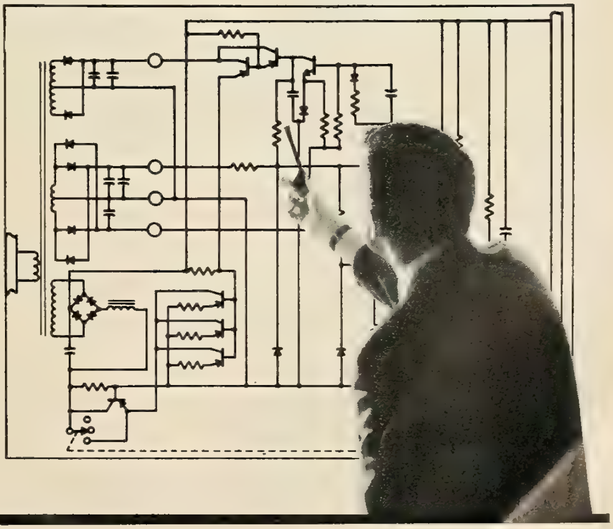

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Headquarters, Procurement Division Washington, D.C.

Tel.: WO 2-4017

Procurement Officer: *Albert A. Clagett*
Small Business Specialist: *E. W. Quintrell*

Interests are: *Liquid hydrogen; reliability studies; the initial phases of research and development projects; recruitment advertising services; mobile lecture-demonstration units, exhibits, motion picture services; management analysis surveys, and various consultant and professional services; and all foreign contracts.*

Ames Research Center Moffet Field, Calif.

(Mountain View, Calif.)
Tel.: 961-1111

Procurement Officer: *A. S. Hertzog*
Small Business Specialist: *John C. Delaney*

Interests are: *A wide range of phenomena in the physical sciences, the space sciences and the life sciences, including studies in entry and environmental physics; guidance and control systems and aeronautics; studies in solar physics, planetary environments and geophysics; and physiological and behavioral sciences, exobiology and human factors.*

Flight Research Center Box 273, Edwards, Calif.

Tel.: CL 8-2111

Procurement Officer: *Morris E. Bowling*
Small Business Specialist: *Stephen C. Kucharik*

Interests are: *Aeronautic projects, electronic systems, biotechnology, and tracking and data acquisition.*

Goddard Space Flight Center Greenbelt, Maryland

Tel.: GR 4-9000

Procurement Officer: *Gordon H. Tyler*
Small Business Specialist: *Harry H. O'Toole*

Interests are: *Satellite systems and equipment for applications satellite projects, unmanned scientific satellite projects, and worldwide NASA tracking and data acquisition operations.*

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Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena 3, Calif.

Tel.: SY 0-6811

Procurement Officer: *T. W. Candee*
Small Business Specialist: *G. R. Lawrence*

Interests are: *Spacecraft and equipment for carrying out lunar, planetary, and deep-space unmanned scientific missions, and for research programs and flight projects, including advanced development and experimental engineering investigations to further space technology.*

Langley Research Center
Hampton, Virginia

Tel.: 722-7961

Procurement Officer: *Sherwood L. Butler*
Small Business Specialist: *Joseph F. Braig*

Interests are: *Support of broad-scale investigations in vehicle configurations, materials and structures, and the mechanics of flight; problems of space travel and reentry; application of new materials; supersonic and hypersonic flight; and tracking and data acquisition.*

NASA Launch Operations Center
Office of Procurement
and Contracts
Cocoa Beach, Florida

Tel.: 783-8003

Procurement Officer: *Gerard A. Michaud*
Small Business Specialist: *Thomas M. Davis*

Interests are: *Equipment for launch, integration and checkout of space vehicle systems; design and construction of all facilities and ground support equipment.*

Lewis Research Center
21000 Brookpart Rd.
Cleveland 35, Ohio

Tel.: 252-7700

Procurement Officer: *Edward S. Hicks, Jr.*
Small Business Specialist: *Norman C. Prahst*

Interests are: *High energy chemical, nuclear and electric rocket engines and space power systems; materials and metallurgy; cryogenic and liquid-metal heat-transfer fluids; pumps and turbines; combustion processes; propellants; tankage; injectors; chambers; nozzles; system control dynamics; plasmas and magnetohydrodynamics; space meteoroid and zero-gravity effects.*

Manned Spacecraft Center
Houston 1, Texas

Tel.: WA 8-2811

Procurement Officer: *Dave W. Lang, Jr.*
Small Business Specialist: *H. T. Christman*

Interests are: *Equipment for manned space flight programs, including spacecraft, life-support systems and other subsystems.*

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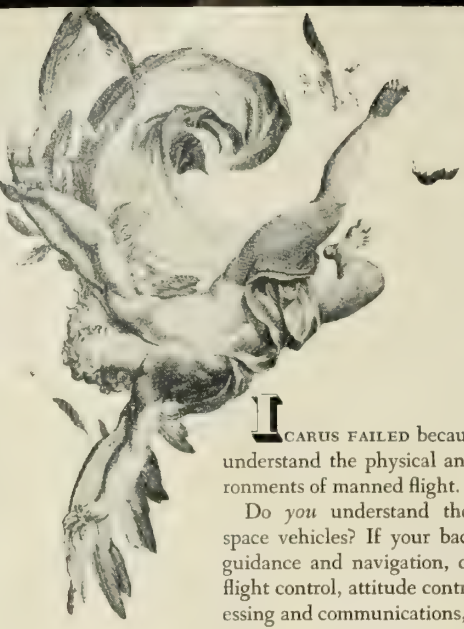

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Some current studies under way at the IBM Space Guidance Center—located in central New York State, bordering on the Finger Lakes vacationland area — include re-entry guidance and control, and space station data management and communications — all representative of challenging future programs. IBM is an Equal Opportunity Employer.

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IBM Space Guidance Center
Owego, New York

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Marshall Space Flight Center Huntsville, Alabama

Tel.: 536-8516

Procurement Officer: *Wilbur S. Davis*
Small Business Specialist: *Emil J. Havrilla*

Interests are: *Equipment related to development and provision of launch vehicles and space transportation systems; and advanced studies and research in the general fields of astronautics.*

Northeastern Office
30 Memorial Drive
Cambridge 42, Mass.

Tel.: 491-1500

Director: *Franklyn W. Phillips*
Assistant Director for Regional Development: *James B. Cahalane*
Small Business Specialist: *Edward J. O'Donnell*

Interests are: *NASA liaison office for the area.*

Space Nuclear Propulsion Office US Atomic Energy Commission Washington 25, D.C.

Tel.: HA 7-7800, Ext. 3036

Cleveland Extension Office:
NASA, 21000 Brookpart Rd., Cleveland 35, Ohio, Tel. 252-7700. Procurement Officer: *George Kimball*

Nevada Extension Office:
NASA, PO Box 1676, Las Vegas, Nev., Tel. 385-4223. Procurement Officer: *Thurman H. Lautenschlager.*

Interests are: *Basic research on reactors, engine systems, vehicles; development of practical heat-exchanger-type reactors, engines and stages; development of reliability, and operation of nuclear-powered stages in launch vehicles for flight test purposes.*

Wallops Station Wallops Island, Va.

Tel.: VA 4-3411

Procurement Officer: *Louis T. Birch*
Small Business Specialist: *Harry Hammond*

Interests are: *Support equipment for launch of non-orbital and orbital experiments up to Scout size; radars and telemetry systems; photographic facilities; meteorological coverage and recovery services.*

Western Operations Office
150 Pico Boulevard
Santa Monica, Calif.

Tel.: EX 3-9641

Procurement Officer: *Earle Sample*
Small Business Specialist: *Alex Mirosav*

Interests are: *Liaison responsibility for NASA contract activities located west of Denver.*

AIR FORCE SYSTEMS COMMAND

Headquarters AFSC
Andrews AFB, Md.

Tel.: 981-6631 or 981-3288
(Washington, D.C.)

Mail Office Symbol: SCMKP-3
Contractor Relations and Sources: *LeRoy E. Olson*
Small Business Executive: *John C. Eiden*

Electronic Systems Division
L. G. Hanscom Field, Mass.

Tel.: CR 4-6100 (Bedford)

Mail Office Symbol: ESKB. Ext. 2244
Contractor Relations and Sources: *Norman Mullen*
Small Business Office: *John Condon*

Interests are: *Complete acquisition program for electronic systems.*

Aeronautical Systems Division
Wright-Patterson AFB, Ohio

Tel.: CL 3-7111 (Dayton)

Mail Office Symbol: ASKS. Ext. 23222,
Contractor Relations and Sources: *Miss Betty Weisbrod*
Small Business Office: *George Rattenbury*

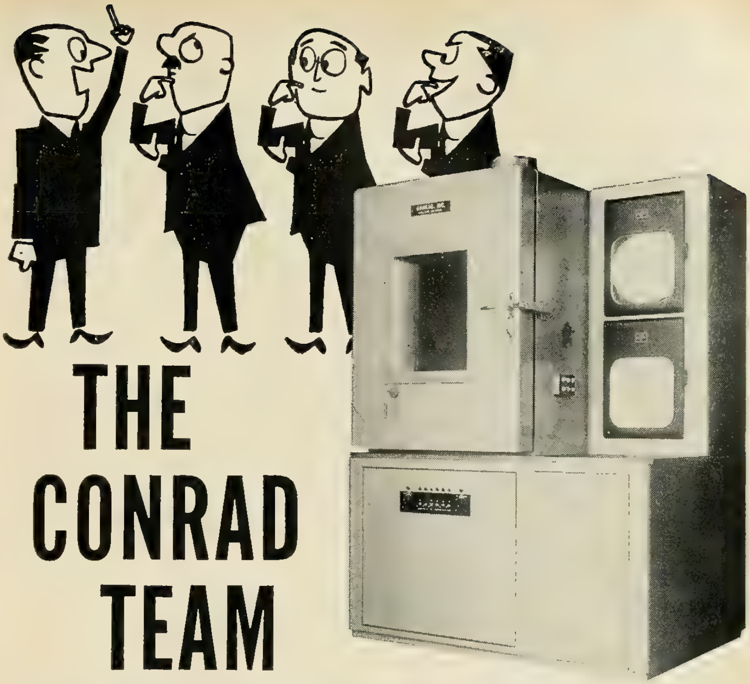
Interests are: *Complete acquisition program for aeronautical systems and applied research in guidance systems for aircraft and missiles; flight control, propellers and rotors testing, including aerodynamic structural and environmental tests; powerplants; ground equipment; aeromedical equipment; airborne equipment; human factors research; airborne electronic equipment; materials; aeronautical science research, including chemistry, mathematics, physics, fluid dynamics, mechanics and system dynamics; aircraft and missile systems components; aerodynamics, including instruments, structure, design, dynamics control and propulsion.*

Aerospace Medical Division
Brooks AFB, Tex.

Tel.: LE 2-8811 (San Antonio)

Mail Office Symbol: AMKS Ext. 23202
Contractor Relations and Sources: *T/Sgt. Francis A. Vouri*
Small Business Office: Same

Interests are: *Life sciences; human factors; aerospace medicine; biosciences; biomedicine; behavioral sciences; space medicine; biotechnology; human engineering; human resources; aviation medicine and space biology.*



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Phone: MUrdock 8-6100

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Components for Industry
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Phone: NE 7-9601

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NAECO Associates, Inc.
733 Fifteenth St. N.W.
Phone: (202) 393-0451

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Phones: 299-2829—299-5327

Texas: Dallas 6:
Wright Industrial Products
5738 N. Central Expressway
Phone: (214) 824-2571

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Precision strain gages utilizing the one-piece etched resistance filament principle are now being produced with an encasement which is weldable to aluminum as well as to other metals. Extensive surface preparation for aluminum welding is no longer necessary. The new gage retains the same inherent temperature compensation, rugged construction, and space saving miniaturization of the swaged steel gages and is attached quickly through the use of stored-energy welding equipment. Gages extend only 0.02 inch above surface. All models are available in integral lead design.

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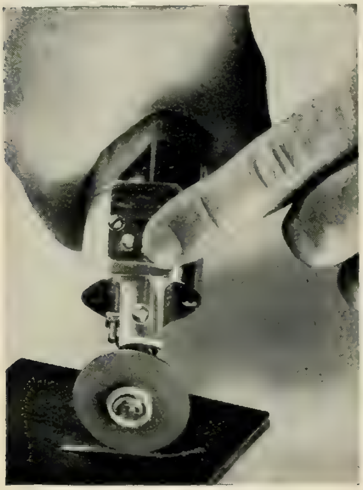
Rotary Welding Tool



Evenly spaced spot welding is automatically supplied for the installation of weldable strain gages by the Microdot Rollectrode. The motor-driven wheel serves as an electrode in the welding operation and produces approximately 32 accurate spot welds per inch in a minimum of time. Rotary welding is especially recommended for strain gage applications but is also useful in the installation of other instruments constructed of thin metal and for applications in severe environmental conditions.

MICRODOT INC.

220 Pasadena Avenue
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Overseas: MICRODOT AG, Zug, Switz.

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Space Systems Division
AF Unit Post Office
Los Angeles 45, Calif.

Tel.: OR 0-1444

Mail Office Symbol: SSKB. Ext. 1005
Small Business and Contract Relations Officer: *Roy A. Watkins*
Source Specialist: *J. Krueger*

Interests are: *Acquisition of space vehicle systems and components.*

Ballistic Systems Division
Norton AFB, Calif.

Tel.: TU 9-4411 (San Bernardino)

Mail Office Symbol: BSKS. Ext. 6011
Small Business and Contractor Relations and Sources Officer: *L. R. McGary*

Interests are: *Acquisition of ballistic missile systems and components.*

Air Force Flight Test Center
Edwards AFB, Calif.

Tel.: 258-2111 (Town of Edwards)

Mail Office Symbol: FTKB. Ext. 20121/29461
Contract Relations and Sources Officer: *Mrs. Ruth Davis*
Small Business Officer: *J. A. Beucherie*

Interests are: *Testing of new aircraft systems; research aircraft; aircraft components; flight test instrumentation; rocket propulsion; and parachutes.*

Air Force Special Weapons Center
Kirtland AFB, N.M.

Tel.: CH 7-1711 (Albuquerque)

Mail Office Symbol: SWKSR. Ext. 2917
Small Business Office and Contractor Relations and Sources Officer: *M. H. Nickerson*

Interests are: Research, development, test and evaluation of Air Force components of equipment related to atomic weapons.

Air Force Missile Test Center
Patrick AFB, Fla.

Tel.: UL 7-7545 (Cocoa Beach)

Mail Office Symbol: MTKSA
Small Business Office and Contractor Relations and Sources Officer: *Charles C. Furtado*

Interests are: *Test range instrumentation involving radar, trajectory computers, radio communications, programming timing and firing systems, telemetry receiving, data storage, data separation and presentation, optics and telemetry data reduction.*

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Rome Air Development Center
Griffiss AFB, N.Y.

Tel.: FE 6-3200 (Rome)

Mail Office Symbol: RAKS. Ext. 5220
Small Business and Contractor Relations and Sources Officer: *John Vella*

Interests are: *Radar communications; navigation; electronic warfare; intelligence; support equipment for radar and communications; specialized support, including human engineering and technical writing, guided missiles including aerodynamics and ballistic guidance control, handling and launching and propulsion.*

Air Proving Ground Center
Eglin AFB, Florida

Tel.: EG 67-2841, 42, 43

Mail Office Symbol: PGKS
Small Business Office and Contractor Relations and Sources Officer: *J. V. Leftwich*

Interests are: *Research, development, test and evaluation of guns and other aircraft weapons; ammunition; rockets; bombs; and fire control components and systems.*

Air Force Missile Development Center
P.O. Box 393, Holloman AFB New Mexico

Tel.: GR 3-6511, 3-6531 (Alamogordo)

Mail Office Symbol: MDKS. Ext. 46861
Small Business Office and Contractor Relations and Sources Officer: *D. P. Hathcock*

Interests are: *Guided missiles—conduct of research and development of guided subsystems and components. R&D in the field of human factors, including biodynamics and space biology. Execute Air Force responsibilities incident to the operation of the proving ground, including operation of special instrumentation in direct support of the Center mission.*

Arnold Engineering Development Center
Arnold Air Force Station, Tenn.

Tel.: GL 5-2611 (Tullahoma)

Mail Office Symbol: AEKS. Ext. 509
Small Business Office and Contractor Relations and Sources Officer: *J. Moriarty*

Interests are: *Aerodynamics, research nd development of powerplants related to peration and tests of air breathing proulsion systems (i.e. turbojet, ramjet, and urboprop); problems associated with high emperature materials and unique mechancal, electrical and thermodynamic probems, all related ot the construction of arge and complex engine test facilities; nd wind tunnels involving heavy construcion of complicated machinery and assoiated ducting.*

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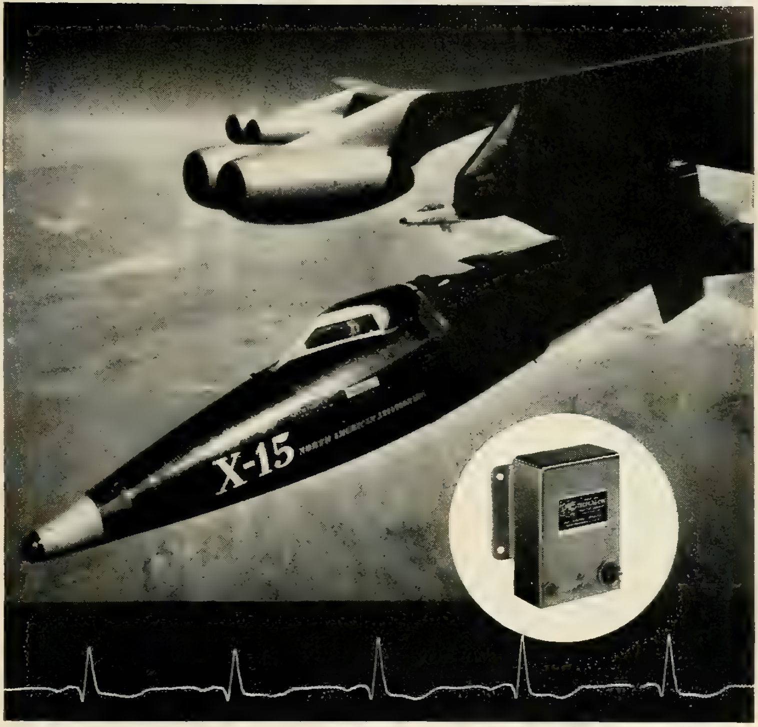

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Director of Procurement and Production:
Maj. Gen. L. W. Fulton

Mobile Air Materiel Area Brookley AFB, Ala.

Director of Procurement and Production:
Col. W. H. Harrell

Interests are: *Jupiter missile; F-84, F-105, B-66, SA-16 aircraft.*

Middletown Air Materiel Area Olmsted AFB, Pa.

Director of Procurement and Production:
Col. N. J. Beaudrias

Interests are: *Falcon missile; cargo, helicopter, trainer and liaison aircraft.*

Ogden Air Materiel Area Hill AFB, Utah

Director of Procurement and Production:
Col. R. J. Iverson

Interests are: *Minuteman, Bomarc and Snark missiles; F-4C, F-101, F-89, B-26 aircraft.*

Oklahoma City Air Materiel Area Tinker AFB, Okla.

Director of Procurement and Production:
Col. P. J. Kuhl

Interests are: *Quail and Hound Dog missiles; B-29, B-47, B-50, KC-97, KC-135, C-137 aircraft.*

Rome Air Materiel Area Griffiss AFB, N.Y.

Director of Procurement and Production:
Col. R. V. Kirkland

Interests are: *Ground communications equipment, including the early warning systems of the Far North.*

Sacramento Air Materiel Area McClelland AFB, Calif.

Director of Procurement and Production:
Col. F. E. Oliver

Interests are: *Discoverer, Samos and Midas space systems; F-80, F-86, F-100, F-104, F-108, F-111, F8F, F-6, T-28, T-33 aircraft.*

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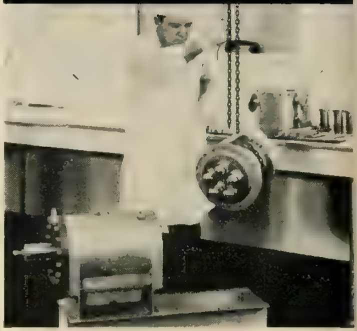

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Director of Procurement and Production: *Col. Abraham Drieseszen*

Interests are: *Atlas, Titan and Thor missiles.*

Warner Robins Air Materiel Area
Robins AFB, Georgia

Director of Procurement and Production: *Col. Harry Zipper*

Interests are: *Matador and Mace missiles; cargo aircraft.*

Air Procurement Region, Europe
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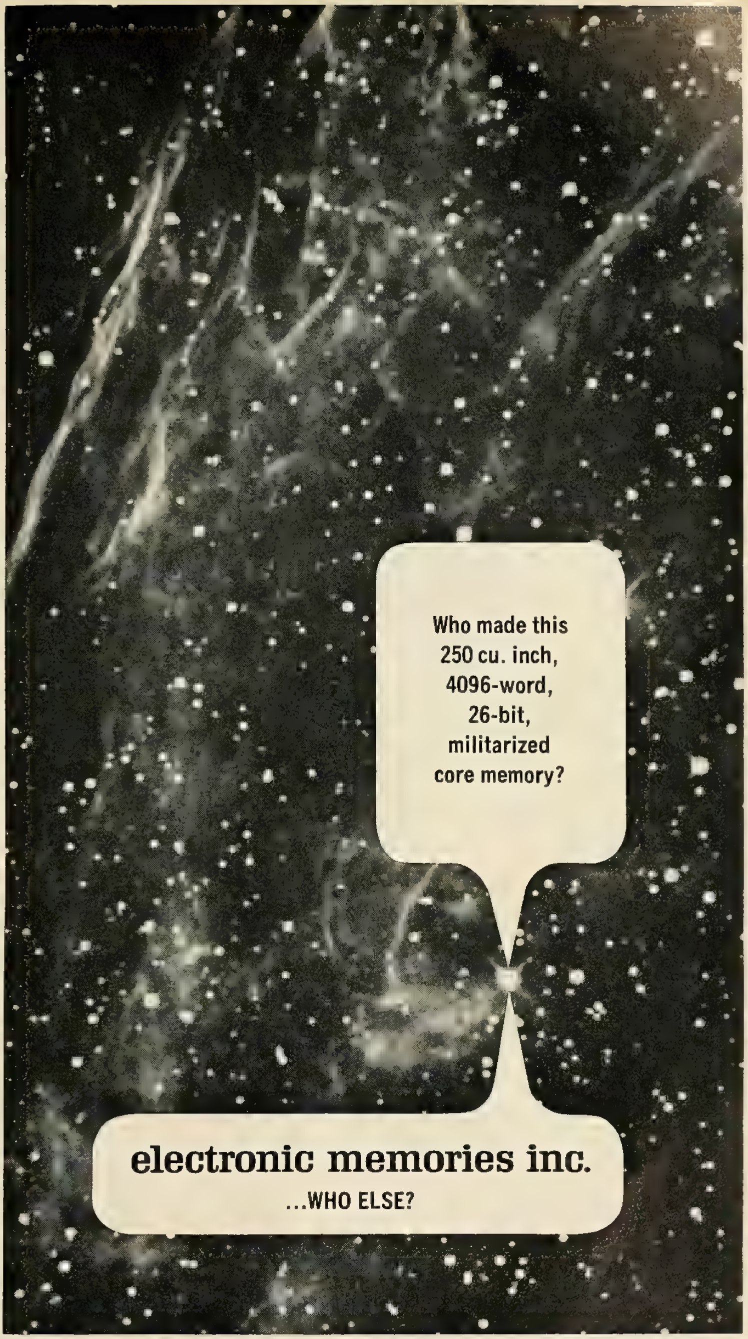
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Mail Symbol: AMSWE
Director: *Maj. Gen. N. M. Lynde*

Interests are: *Weapons and combat vehicles.*

Army Weapons Command
Watervliet Arsenal, N.Y.

Tel.: AR 3-4610

Mail Symbol: SWEWV
Director: *Col. K. T. O'Keefe*

Interests are: *Same as Army Weapons Command.*

Army Munitions Command
Chemical, Biological, Radiological Agency
Edgewood, Md.

Tel. Edgewood 1000

Mail Symbol: SMUCB
Director: *Brig. Gen. F. J. Delmore*

Interests are: *Chemical, biological and radiological materials.*

Army Munitions Command
Ammunition Procurement and Supply Agency
Joliet, Ill.

Tel.: HA 3-5551

Mail Symbol: SMUJA
Director: *Lt. Col. P. J. Savage*

Interests are: *Nuclear and non-nuclear ammunition; rocket and missile warhead sections; propellants; explosives and pyrotechnics; metrological and propellant-actuated devices.*

Army Munitions Command
Fort Detrick, Frederick, Md.

Tel.: MO 3-4111

Mail Symbol: SMUFA
Director: *Col. C. S. Costo*

Interests are: *Same as preceding.*

Army Munitions Command
Frankford Arsenal, Philadelphia, Pa.

Tel.: JE 5-2900

Mail Symbol: SMUFD
Director: *Col. E. W. Eifler*

Interests are: *Same as preceding.*

Army Munitions Command
Picatinny Arsenal, Dover, N.J.

Tel.: FO 1-2100

Mail Symbol: SMUPA
Director: *Col. R. R. Klanderman*

Interests are: *Same as preceding.*

Army Electronics Command
Fort Monmouth, N.J.

Tel.: 53-2110

Director: *Maj. Gen. Stuart S. Hoff*

Interests are: *Communications; electronic warfare; combat surveillance; automatic data processing; radar; and meteorological materiel.*

Army Electronics Command
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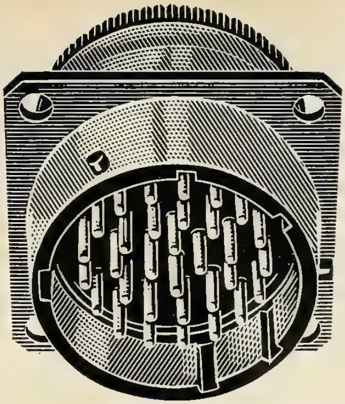
Tel.: OX 6-5900

Director: *Cmdr. W. F. Hawley*
Code: NPSP



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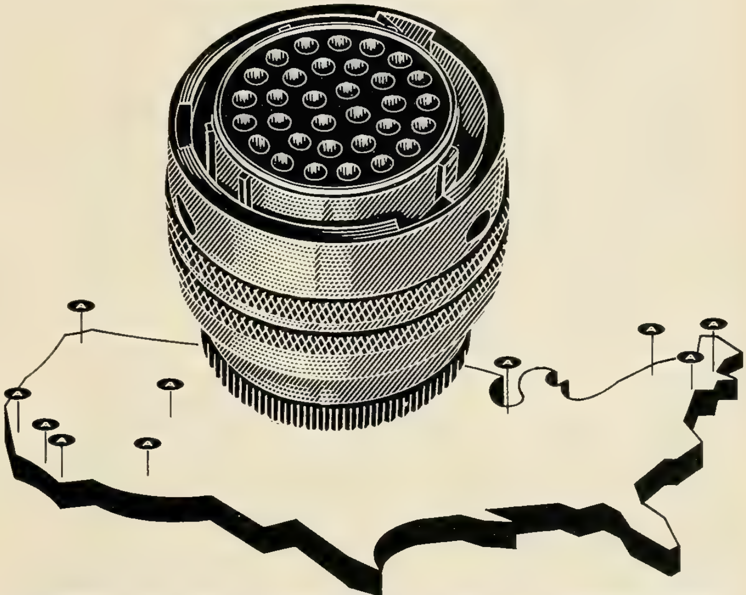

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A Chronology of Fiscal 1963

JULY, 1962

July 21: Premier Khrushchev reported first firings (Arctic Ocean) of a Soviet *Polaris*-type missile.

July 26: A *Polaris A2* carrying *A3* components was destroyed after launch from a land pad at Cape Canaveral.

—A *Thor* missile was destroyed carrying the fourth of a series of nuclear devices for detonation at high altitudes, the third failure in four attempts. The only success came July 9, when an artificial radiation belt of considerable magnitude was created by the high-altitude blast.

July 28: *Cosmos* 7 unmanned satellite was launched into elliptical orbit by the Soviet Union.

AUGUST, 1962

Aug. 1: Air Force conducted first successful launch of the *Atlas F* from an underground silo.

—*Jupiter* IRBM was fired by Italian Air Force troops at Cape Canaveral.

Aug. 5: Air Force launched secret satellite from Pt. Arguello with *Atlas-Agena* vehicle.

Aug. 6 week: DOD killed another attempt by the Air Force to increase its military space mission by refusing to approve funds for a joint NASA-Air Force bio-astronautics program.

Aug. 7: Navy shot down a *Regulus* with an air-launched *Sparrow* off Pt. Mugu, Calif.

—First *Polaris A3* launched from the Cape. Its first stage functioned well but flight fell short when its second stage malfunctioned.

Aug. 9: An advanced *Minuteman* broke in two shortly after launch from Cape Canaveral.

—Two *Atlases* were launched in quick succession in routine training at Vandenberg AFB.

Aug. 10: Britian announced decision to discontinue *Blue Water* program.

Aug. 10: An advanced *Atlas F* was intentionally destroyed after a malfunction at Vandenberg AFB.

—A modified Lockheed *Polaris A2* traveled 1,700 miles down the Atlantic Missile Range after a Cape Canaveral launch.

Aug. 11: Soviet Cosmonaut Maj. Andrian Nikolayev began record-shattering flight in *Vostok III* which ended Aug. 15.

Aug. 12: Col. Pavel Popovich joined Nikolayev, reportedly attempted a space rendezvous, in *Vostok IV* coming within about 4 miles of success and was recovered Aug. 15.

—*Missile B* (now designated *Lance*) program definition contracts let by Army to Chrysler Corp. and Chance Vought Div. of Ling-Temco-Vought.

Aug. 17: *Polaris A2* missile blew up only 15 sec. after launch from land pad at Cape Canaveral.

—Douglas Aircraft Co. successfully fired cluster of 6 RL7-10 A-3 liquid oxygen-hydrogen engines.

—Senate passed administration's communications satellite corporation bill by 66-11 vote, authorizing creation of a private corporation to develop and operate a *Telstar*-type communications system.

Aug. 21: Martin *Pershing* successfully fired from mobile transporter-erector-launcher.

Aug. 23: AF secret satellite launched on *Blue Scout* from Vandenberg AFB.

Aug. 24: *Nike-Zeus* launched from Pt. Mugu destroyed in flight after third stage malfunctioned.

Aug. 27: *Mariner II* successfully launched from Cape Canaveral by an *Atlas-Agena* booster. The probe was to report on Venus temperature, rotation, electromagnetic field and other characteristics.

—*Polaris* missile carrying components of advanced *A3* version made perfect flight from Cape Canaveral.

Aug. 27 week: Senate restored $60 million of $100 million cut made in NASA's appropriations bill by House.

Aug. 28: AF secret satellite launched on *Atlas-Agena* from Vandenberg.

—*Nike-Zeus* successfully launched by Army from White Sands Missile Range.

Aug. 30: An improved first stage for NASA's *Scout* vehicle was successfully flight-tested from Wallops Island, Va. The

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SEPTEMBER, 1962

Sept. 3 week: Design changes in the *Centaur* vehicle threaten *Surveyor, Mariner* and other programs.

Sept. 4: Midcourse guidance correction made on the *Mariner II* Venus probe, well on its way to the planet.

Sept. 6: Navy's new 2,500-mile *Polaris A3* failed to achieve full flight distance.

Sept. 10 week: NASA started building new satellite in crash program to measure radiation belt created by the high-altitude U.S. nuclear explosion last July 9.

Sept. 11: First operational *Atlas F* silo complex—worth $150 million—turned over to SAC at Salina, Kan.

Sept. 12: Martin *Titan II* launched from Cape Canaveral on 5,000-mile flight.

—Secret AF satellite launched from Vandenberg AFB by a *Thor-Agena B.*

—100th *Atlas* to be launched from Cape Canaveral fired 1,000 miles downrange.

Sept. 18: *Tiros VI* meteorological satellite boosted into orbit.

—An operational Wing I *Minuteman* was fired from Cape Canaveral on a "highly successful" flight more than 3,000 miles downrange.

—Army *Redhead-Roadrunner* successfully completed its first low-level flight.

Sept. 19: *Minuteman* missile closely resembling operational configuration successfully fired from Cape Canaveral.

Sept. 25: *Skybolt* missile 95% successful in shortened flight when second stage failed to burn for the programmed time.

Sept. 24 week: AF disclosed plans to enter *Gemini* program.

Sept. 26: *Pershing* scored 33rd success in 40 flights.

Sept. 27: Canada launched *Alouette* satellite on NASA *Thor-Agena B* from Vandenberg AFB to become the third nation to orbit a satellite.

—Soviets launched *Cosmos 9* unmanned spacecraft.

—*Nike-Zeus* antimissile missile fired from above-ground launcher at White Sands, meeting all test objectives.

Sept. 28: *Minuteman* ICBM made first flight from silo but malfunction required destruction of missile.

Sept. 29: Secret AF satellite launched from Vandenberg.

OCTOBER, 1962

Oct. 1 week: Three contractors selected by DOD to continue program definition studies of AF *MMRBM:* Aeronutronic Division of Ford for re-entry system; Thiokol, propulsion; and Goodyear for transporter-launcher.

Oct. 2: *NASA's S-3A* satellite successfully launched from Cape Canaveral by *Thor-Delta* rocket.

Oct. 3: Astronaut Walter Schirra launched from Cape Canaveral at 8·15 a.m., recovered same day after six-orbits of "textbook flight" in *MA-8*.

Oct. 10: Secret satellite launched from Vandenberg AFB by Air Force.

Oct. 8 week: Kennedy named 13 Communications Satellite Corp. incorporators.

—Advanced *Minuteman* details revealed for first time.

—NASA added five more satellites to its *Ranger* lunar spaceflight series.

Oct. 12: *Titan II* ICBM chalked up fourth success in six test flights.

Oct. 14: Merger plans for Institute of Aerospace Sciences and the American Rocket Society approved by governing bodies of two organizations.

Oct. 17: *Cosmos 10* launched by Soviets in unmanned flight.

Oct. 19: *Atlas F* ICBM successfully fired from Cape Canaveral by all-Air Force crew.

Oct. 20: *Cosmos 11* launched by Soviets in another unmanned space research flight.

—An especially built missile powered by a *Sergeant* booster carried a nuclear device to an altitude of 20-30 miles over Johnston Island with low-yield blast.

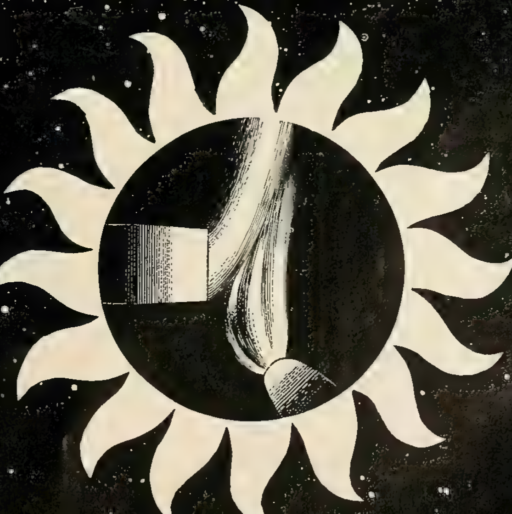
—Cuban-USSR missiles disclosed.

Oct. 24: *Nike-Zeus* launched from Pt. Mugu destroyed before third-stage ignition.

Oct. 26: SAC crew launched *Atlas D* from Vandenberg AFB in routine exercise.

—Secret AF satellite launched from Vandenberg AFB.

—*Titan II* ICBM fired successfully on



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Thor boosted sub-megaton nuclear device over Johnston Island.

Oct. 28: *Explorer XV* went into orbit from Cape Canaveral spinning too fast for two of seven experiments aboard to function.

Oct. 29 week: NASA awarded three Saturn contracts totalling $333 million. Winners: North American ($319 Million), Boeing Co. and Douglas.

Oct. 31: *Thor-Ablestar* vehicle boosted *ANNA* beacon satellite into orbit from Cape Canaveral.

NOVEMBER, 1962

Nov. 2: Soviets launched *Mars I*, a 1,965-lb. automatic interplanetary station from a heavier station in a parking orbit. It was expected to pass Mars June 25, 1963.

—Second successful field firing of the solid-fueled *Sergeant* from White Sands Missile Range.

Nov. 4: A *Nike-Hercules* rocket carried a low yield (less than 20 kt) nuclear device to an altitude of 20-30 miles over Johnston Island, closing the Dominic Series.

Nov. 5: A *Polaris A3* failed 30 sec. after launch from a Cape Canaveral pad.

Nov. 6: AF secret satellite launched on a *Thor-Agena* vehicle from Vandenberg AFB.

Nov. 7: The 150th *Atlas* fired was launched from Cape Canaveral by an Air Force crew.

Nov. 8: Two successful test firings of *Nike-Zeus*—at Pt. Mugu and White Sands Missile Range, respectively.

Nov. 12 week: NASA announced plans to re-program funds to begin construction of facilities at White Sands Missile Range for *Gemini* and *Apollo*.

—Grumman Aircraft Engineering Corp. selected contractor for Lunar Excursion Module.

—Chance Vought won $100 million contract for development and initial production of *Missile B (Lance)*.

Secret AF launch carried tetrahedral satellite (TRS) to measure radiation effects of July 9 nuclear blast.

—*Mariner II* power mysteriously returned after temporary cutoff.

—First joint U.S./Australian sounding rocket venture failed when malfunction in launch vehicle occurred 38 seconds after launch at Wallops Island.

Nov. 16: Third *Saturn C-1* made perfect flight from Cape Canaveral.

Nov. 17: *Polaris A3* was destroyed shortly after first-stage separation.

Nov. 19: *Minuteman* succeeded in Cape Canaveral silo launch.

Nov. 19 week: Hughes Aircraft Co. won *MMRBM* contract.

Nov. 21: AF secret probe launched on *Blue Scout* vehicle.

Nov. 24: AF secret satellite launched by *Thor-Agena* booster combination.

Nov. 27: Army *Pershing* chalked up another successful mission.

Nov. 28: *Nike-Zeus* launched over Pacific Missile Range and successfully maneuvered with controlled blasts of rocket exhausts.

Nov. 28: *Skybolt* launched from B-52 over Cape failed to gain altitude and dropped into ocean.

Nov. 29: *Nike-Zeus* intercepted an electronically simulated target in a development test at White Sands.

Nov. 30: Kiwi B-4A tested in static test.

Nov. 30: NASA successfully launched two sounding rockets—a *Nike-Cajun* and a *Nike-Apache*, from Wallops Island, initiating a five-nation cooperation series aimed at measuring upper atmospheric conditions. Other countries: Argentina, Australia, Canada and France.

DECEMBER, 1962

Dec. 3 week: Secretary of Defense Robert McNamara announced decision to cancel *Skybolt* air-launched ballistic missile program.

Dec. 4: A *Nike-Hercules* missile exploded over McGregor Missile Range killing a French Lieutenant and injuring four other persons.

—AF shot another secret satellite into orbit from Vandenberg AFB, marking the 100th launch of *Thor* as a space booster. Of these 93 were successful.

Dec. 5: Final R&D *Atlas F* launched very successfully in 5,000-mile ride to a target area near Ascension Island.

Dec. 5: AF successfully fired a Martin *Titan I* ICBM 4,000 miles from Vandenberg AFB.

Dec. 6: *Titan II* programmed for 8,000 miles blew up two minutes after launch from Cape.

—*Polaris A3* encountered sixth straight failure.

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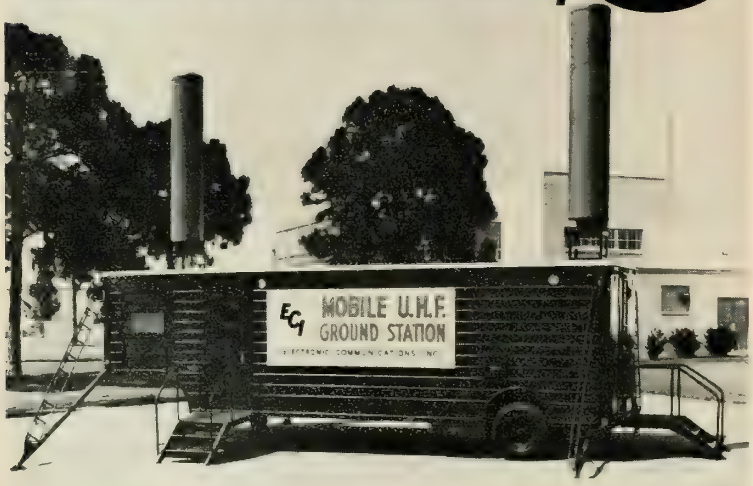

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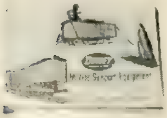

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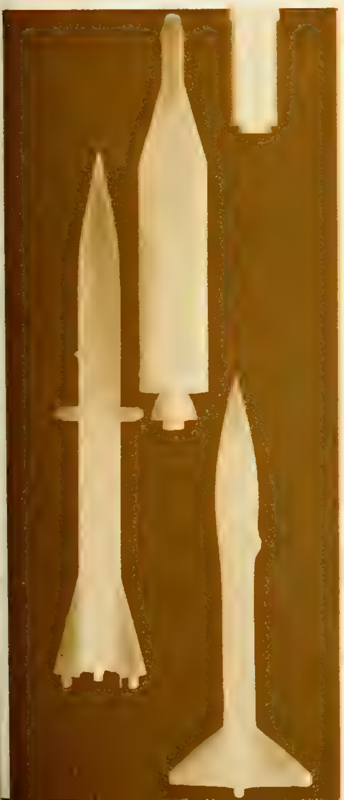

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Dec. 7: *Minuteman* with Avco Mark 11 reentry package fired from Cape silo in successful test.

Dec. 10: *Minuteman* destroyed after malfunction during launch from Vandenberg.

—*Pershing* fired successfully from Cape Canaveral.

Dec. 10 week: *Minuteman* operational at Malmstrom AFB, Mont.

Dec. 12: AF secret satellite launched by *Thor-Agena* booster.

—Army *Nike-Zeus* successfully intercepted an *Atlas* target vehicle over Kwajalein Island, the second successful intercept.

Dec. 13: *Relay* communication satellite launched from Cape Canaveral but failed to maintain full power for primary tests.

—Two Canadian *Black Brant* sounding rockets fired from Wallops Island in joint Canada-US test.

—AF secret satellite from Vandenberg launched on *Thor-Agena.*

Dec. 16: *Explorer XVI* micrometeoroid satellite orbited by a *Scout* launch vehicle from Wallops Island.

Dec. 17: AF secret satellite failed after launch by *Atlas-Agena.*

Dec. 18: *Blue Scout* launched secret satellite from Pt. Arguello.

—*Transit 5-A,* Navy's navigational satellite, put into polar orbit by *Blue Scout* booster. However, failure in command receiver prevented transmission of navigational aids to ships and submarines.

—*Atlas D* blew up shortly after launch by SAC crew from Vandenberg.

Dec. 19: *Polaris A2* carrying *A3* guidance successfully fired from Cape Canaveral pad in test of smallest inertial guidance system U.S. has built for military rocket.

—*Nike-Zeus* fired successfully in 19th and final test of *Zeus* at Pt. Mugu. Tests continue at White Sands and Kwajalein.

Dec. 22: First successful intercept of an ICBM target using decoys by *Nike-Zeus* over PMR.

Dec. 28: First *Mariner II* results released by NASA scientists. Reveals slow rotation, low radiation and absence of magnetic field.

Dec. 31 week: Theodore von Karman named winner of the National Medal of Science.

JANUARY, 1963

Jan. 3: *Relay,* NASA's communications satellite, resumed performance after a backup system was commanded on by ground instruction Dec. 31.

—Boeing *Bomarc B* made first successful low-altitude aircraft intercept from Eglin AFB, Fla. A new electronic device installed in the plane tracked the drone target.

Jan. 7: AF secret satellite launched from Vandenberg AFB by a *Thor-Agena* combination.

Jan. 7 week: NASA dropped plans for two repeat flights to vicinity of Venus because of outstanding success of *Mariner II.*

—*Telstar I* repaired in flight in unprecedented ground operation by Bell Telephone Laboratory scientists.

Jan. 7: A Wing II *Minuteman* was only partially successful in a launch from Cape Canaveral, falling slightly short of a 5,000-mi. target.

Jan. 10: Martin *Titan II* fell short of its intended 6,300 mile range.

Jan. 14 week: Great Britain announced plans for four *Polaris*-launching subs at a cost estimated at $700 million.

—Navy launched Martin *Bullpup B* from an AD-4 Skyhawk, first in air-to-surface missile's technical evaluation program.

—President submitted budget of $18.62 billion for missiles and space.

—*Centaur,* liquid hydrogen upper stage, got DX priority—the nation's highest.

Jan. 16: AF secret satellite launched by *Thor-Agena.*

Jan. 17: Martin *Pershing* missile deliberately tilted at liftoff to simulate buffeting effects of strong winds—successfully straightened out and proceeded to a target 200 mi. from Cape Canaveral.

Jan. 21 week: AF denied reports that it had cancelled *MIDAS,* early warning satellite system.

—Hughes Aircraft won $12.2 million contract for development of *Phoenix* air-to-air missile to be fired from TFX fighter.

—Air Force, NASA signed agreement for Air Force participation in *Gemini,* casting doubt on future of *X-20* (*Dyna-Soar*) project.

Jan. 23: *Minuteman* went 4,000 miles down AMR for "flawless" though first flight success of the year.

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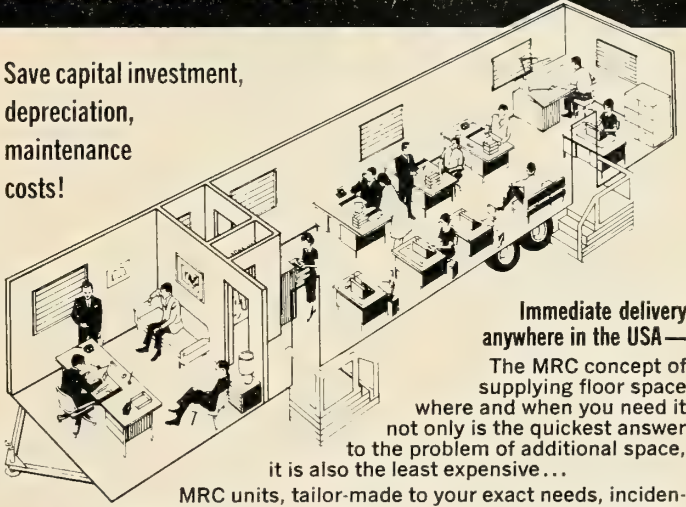

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Jan. 29: SAC crew launched *Titan I* from Vandenberg in successful 5,000-mi. flight.
Jan. 30: Army *Pershing* met all test objectives on a 200-mi. flight from Cape.
Jan. 31: *Atlas* fired from Vandenberg in routine training shot.

FEBRUARY, 1963

Feb. 1: AF launched secret space probe from Pt. Arguello, using *Blue Scout.*

—IAS merged with ARS to form AIAA.

Feb. 4 week: Fairchild Stratos Corp. chosen to build NASA's giant *Meteoroid Detection Satellite (MDS)* to be launched on eighth and ninth *Saturn* flights.

Feb. 11 week: NASA ordered seven more *Tiros* satellites (three funded by Weather Bureau) in addition to eight it has purchased.

—Republic won four-month, $136,640 contract from NASA for *Synchronous Meteorological Satellite* to be placed in 22,420-mi. orbit.

—*Syncom* active communications satellite lost after launch from Cape Canaveral in tricky maneuver to put it into orbit 22,300 miles up.

—*Titan II*—in first attempted firing from a silo—blown up because of faulty umbilical rigging which caused undesirable spin.

Feb. 18: *Polaris A3*, after two successful flights, careened off course and was destroyed.

Feb. 18 week: Bendix Corp. Mishawaka Div. awarded $25 million Navy contract for *Typhon* missile system research and development.

Feb. 19: AF *Blue Scout* launched another secret satellite at Pt. Arguello, Calif.

Feb. 20: Two *Minuteman* 3,000-mi. R&D flights from Cape Canaveral succeeded.

—Army conducted a successful development launch of *Nike-Zeus* at White Sands Missile Range.

Feb. 21: *Polaris A2* fired from submerged USS Thomas Jefferson off east coast of Florida, in 1,400-mi. flight.

Feb. 25 week: Martin Co. awarded $50.2 million for production of *Titan II*, the first production authorization for the AF missile.

—Leo D. Welch, chm. of the board of Standard Oil Co. of N.J., and AF Undersecretary Joseph V. Charyk named chairman and president respectively of the Communications Satellite Corp. by President Kennedy.

—NASA ordered 14 more *Delta* rockets from prime contractor Douglas Aircraft, bringing to 40 the number purchased since April 1959.

Feb. 25: *Pershing* met all test objectives in shot from Cape.

Feb. 26: NASA announced *Mariner II* findings—temperatures on Venus average 800°F, and a heavy hydrocarbon cloud layer covers the planet.

Feb. 28: Another *Atlas* launched from Vandenberg AFB in routine shot.

—Secret satellite launched by AF ran into difficulties during boost and was destroyed.

MARCH, 1963

Mar. 1: An advanced *Atlas* missile was fired more than 5,000 miles from Cape Canaveral.

Mar. 4: *Pershing* fired from sandy sloped surface at Cape Canaveral met all test objectives.

—DOD-NASA work on agreement to cover *Dyna-Soar* by joint management, as with *Gemini.*

Mar. 7: USS Thomas Jefferson nuclear submarine launched two *Polaris* missiles from beneath the Atlantic. One was successful.

Mar. 9: *Atlas* launched from Vandenberg exploded on pad.

Mar. 11 week: D. Brainerd Holmes, director of NASA's Office of Manned Spaceflight, testified before Congress that both *Gemini* and *Apollo* were delayed about five months because administration refused to ask for supplemental appropriations to FY 1963 budget.

—*Syncom* satellite, lost after launch, is found by range and range-rate tracking system developed for the satellite by NASA.

Mar. 13: *Pershing* fired successfully from Cape Canaveral.

—Secret space probe aboard a *Blue Scout* at Vandenberg exploded on pad.

Mar. 15-16: Three routine *Atlas* shots made from Vandenberg AFB.

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Mar. 18: *Thrust-Augmented Thor* lifted secret AF satellite. Thrust was 330,000 lbs., almost equal to thrust of *Atlas.*

Mar. 18: Wing II *Minuteman* fired from Cape Canaveral failed 10 seconds after third-stage ignition.

Mar. 19: Range safety officer destroyed *Polaris A3* shot from Cape when it went off course.

Mar. 18, 19, 20: Three Army *Sergeant* missiles were successfully launched from San Nicolas Island against PMR targets in Santa Barbara Channel Islands.

Mar. 21: Martin-Canaveral scored a double success when it flew an AF *Titan II* and Army *Pershing* from Cape Canaveral.

—*Atlas* ICBM fired from Vandenberg has fourth success in a row.

—Soviet Union sent *Cosmos 13* into Earth orbit to gather data for future manned flights.

Mar. 23: *Atlas* exploded shortly after liftoff from Vandenberg.

Mar. 27: Last of interim Wing II *Minutemen* launched successfully from Cape Canaveral.

Mar. 30: NASA launched fourth *Saturn I* from Cape in successful test of booster's engine-out capability.

APRIL, 1963

April 1 week: Charles W. Frick resigned as director of Project *Apollo* at NASA.

—McDonnell Aircraft received $456.6-million contract for work on *Gemini* two-man spacecraft in record contract.

April 2: Russians launched fourth lunar probe, *Lunik IV,* from a parking orbit about the Earth.

—NASA's stainless steel *Explorer XVII* satellite entered almost perfect orbit after being launched aboard a *Delta* rocket. The satellite almost immediately began reporting and accumulated data tripling all previous direct measurements of the neutral gases in the upper atmosphere.

April 3: Army's final *Pershing* R&D program firing resulted in a successful 200-mile flight down the AMR. The 52-shot series, which began in February, 1960, resulted in 44 successes, 6 partials and 2 failures.

Apr. 8-10: *Polaris A3* IRBM first fired successfully, then failed in two launches.

Apr. 8 week: Lockheed Missiles and Space Co. received first U.S. patent on a space station design.

Apr. 10: Wing II *Minuteman* launched from Cape silo made successful 5,000-mi. flight.

Apr. 12-17: Army *Pershing* moved toward operational status with two successful launchings.

Apr. 19: Martin *Titan II* launched from Cape Canaveral failed to fly its 5,000-mi. mission when second stage unexpectedly shut down.

Apr. 22: Russia launched 15th satellite in its *Cosmos* series.

Apr. 22 week: Third consecutive firing of a solid-fueled *Minuteman* under simulated nuclear war operational conditions made from Vandenberg AFB, Calif.

—*Explorer XVII satellite discovered* that Earth is surrounded by a belt of neutral helium atoms.

Apr. 24: Army's Western Electric-built *Nike-Zeus* antimissile missile went through flight maneuvers successfully in development test.

—Successful *Pershing* flight made from Cape Canaveral.

Apr. 26: AF launched secret satellite from Vandenberg on *Thor-Agena* booster.

—*Polaris A3X* launched from USS Observation Island near Cape Canaveral, with only partial success.

—*Blue Scout* boosted secret satellite from Pt. Arguello, Calif.

Apr. 27: *Titan II* successfully completed its first intercontinental range firing from an underground silo at Vandenberg AFB.

Apr. 29 week: Air Force successfully launched *Atlas F* with a Chrysler-built nose cone on a 5,000-mi. flight from Cape Canaveral in conjunction with Advanced Ballistic Re-entry System (ABRES) test program.

—*Gemini* slip to at least second quarter of 1964 conceded by NASA's James E. Webb at Princeton alumni meeting in Washington, D.C.

—Navy sent reorganization plan to Congress.

MAY, 1963

May 1: A *Titan I* being launched from Vandenberg silo exploded before becoming airborne.

—USAF Ship Gen. H. H. Arnold, first

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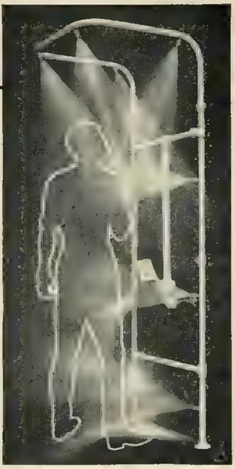

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of two AF Advanced Range Instrumentation Ships (ARIS), dedicated at Port Canaveral, Fla.

May 7: Dr. Theodore von Karman died in Aachen, W. Germany, a few days before his 82nd birthday. Sometimes called the "Father of Astronautics," he lived a "life of unparalled contribution to science and human freedom."

—*Telstar II*, second U.S. commercial communications satellite, boosted into orbit from Cape Canaveral.

May 9: *Minuteman* continued progress with fifth consecutive launch from Vandenberg.

—*Titan II* launched from Cape Canaveral but fell short of target.

May 10: *Polaris A3* successfully fired from pad at Cape Canaveral.

May 13: *Titan II* from Vandenberg a success.

May 13 week: *Shillelagh* missile tested four times in one week with as many successes concluded winter-long testing of weapon under severe Arctic conditions.

—General Electric and a Philco Corp./Space Technology Laboratories team chosen by Air Force for program definition studies of *Medium Altitude Communication Satellite* system.

May 15: AF Maj. L. Gordon Cooper made record *MA-9* flight: 22 orbits, 34-hrs., 20 min., with precision man-controlled reentry and landing.

May 17: Navy's *Polaris A3* completed successful 1,800-mi. flight down AMR from Cape Canaveral.

May 18: *Minuteman* fell short of target but met most test objectives.

May 22: Soviet Union launched 17th unmanned space satellite in a series thought to be in preparation for a new space attempt.

NASA *Scout* carried dummy nuclear reactor 90 mi. over Wallops Island, Va., in preparation for Space Nuclear Auxiliary Power (SNAP) atomic power plant planned by AF next year.

May 24: *Titan II* launched from Cape scored a near bull's-eye on 6,500-mi. flight down AMR, dropping largest nose cone yet carried only a mile from target.

—*Cosmos 18* fired by USSR, the fifth unmanned instrumented satellite launched by the Soviets in six weeks.

May 27 week: Space Technology Laboratories won parallel development contract for Lunar Excursion Module throttleable descent engine.

May 28: *Minuteman* ICBM launched from Cape Canaveral successfully flew more than 4,000 miles down AMR.

JUNE, 1963

June 1: *Atlas F* missile exploded in hole at Walker AFB during routine training exercise by a SAC crew.

June 3 week: AF announced it is studying an advanced ICBM with faster reaction, heavier payload than *Minuteman*.

June 4: *Atlas E* ICBM flew 4,000 miles from Cape Canaveral.

—Six Army missiles fired at White Sands successfully in Presidential command performance: *Honest John, Little John, Sergeant, Hawk, Nike-Hercules* and *Nike-Zeus*. A double firing of the Navy *Talos* failed to intercept QF-80 drone.

—Silo-launched Wing II *Minuteman* carried Mark 11 Avco nose cone 5,000 miles down AMR to point near Ascension Island.

June 6: *Polaris A3* scored success from flat land pad at the Cape.

—D. Brainerd Holmes, Director of NASA's Office of Manned Spaceflight, resigned his position after a long disagreement with top space agency and Kennedy Administration officials over funding for the *Gemini* and *Apollo* programs.

—NASA announced decision not to conduct *MA-10* flight.

—Space Technology Labs chosen to design and fabricate *Pioneer* interplanetary solar probe.

June 12: Another firing of *Atlas* came off routinely from Cape.

—*Atlas-Agena* with undisclosed payload exploded shortly after launch from Vandenberg AFB.

June 14: Russia launched Soviet AF Lt. Col. Valery F. Bykovsky in *Vostok V*.

June 16: Cosmonette Lt. Valentina V. Tereshkova lofted into orbit in *Vostok VI*, on three-day flight.

June 14: DOD announced successful *Nike-Zeus* intercept of *Atlas* ICBM.

June 15: AF *Blue Scout* launch put satellite into orbit from Vandenberg AFB.

June 17: *Polaris A3* fired from USS Observation Island in first success at sea.

June 18: *Minuteman* ICBM launched by SAC crew, first under fully simulated combat conditions.

June 21: *Polaris A3* achieves second seagoing success when launched from USS Observation Island near Cape Canaveral.

June 26, 28: Two *Thor-Agena* boosted satellites launched by AF from Vandenberg AFB.

June 27: Air Force Wing II *Minuteman* successfully fired from underground at Cape Canaveral.

—AF Maj. Robert A. Rushworth qualified for astronaut wings on 50-mi. high *X-15* mission to acquaint himself with "relatively high" altitude operations.

JULY, 1963

July 1 week: General Electric and Martin Co. won $123,319 NASA contracts to tudy the application of nuclear electric power to manned orbiting space stations.

—Boeing Co. selected by NASA to carry out a four-month study of a lunar base concept under a $196,000 contract.

—Houston Integration Mission Control Center complex seen exercising either primary or back-up control of manned orbital *Gemini* flights earlier than anticipated.

July 1: Army *Nike-Zeus* performed successfully in development tests at White Sands Missile Range, N.M.

—AF Wing II *Minuteman* fired successfully from underground at Cape Canaveral.

July 2: Secretary of Defense Robert McNamara observed two *Polaris A2* firings while submerged in nuclear submarine Lafayette near Cape Canaveral.

—NASA launched *Argo D-4* solid-fueled rocket bearing an instrumented payload from Wallops Island, Va., to double check measurements being taken by U.S.-Canadian *Alouette* satellite.

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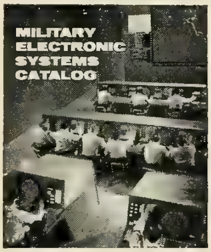

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JULY

Toxicity in the Closed Ecological System, sponsored by U.S. Navy's Special Projects Office and Lockheed Missiles and Space Co., Lockheed Research Laboratories, Palo Alto, Calif., July 29-31.

AUGUST

International Conference and Exhibit on Aerospace Support, sponsored by AIEE, ASME, IRE and AMA, Sheraton-Park Hotel, Washington, D.C., Aug. 4-9.

Sixth Annual Institute of Missile Technology, sponsored by University of Connecticut, Storrs, Aug. 4-16.

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, Electrical Design News and Design News, University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug. 23.

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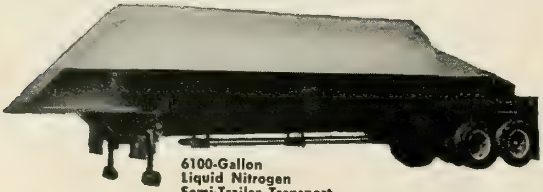

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The World of Missiles & Spacecraft

THE CONTINUALLY growing impact of the missile/space industry on world technology, science, economics and politics is evident by implication in the pages of this annual encyclopedia issue.

Not only the United States and the Soviet Union, but many other nations of the world are involved in the development of hardware in these fields.

Nations other than the U.S. and USSR soon will be able to loft satellites into space—through expansion of their booster capabilities or through such techniques as gun-launching of satellites, described in the July 1 issue of this magazine.

European nations, both individually and in consortium, are developing the ability to play a fuller role in the Space Age. France, pressing down its individualistic path, is rapidly bringing into being a missile and booster capability.

Britain and the U.S. are discussing implementation of the *Polaris* agreement. Further arming of NATO nations with the latest missiles is under consideration.

One need only study the pages of this issue to realize that just as the U.S. monopoly in the atomic field was dissipated, the American and Russian lead in missiles and space is with equal certainty being overtaken by other nations of the world.

This is not intended to suggest that we soon will find other contestants eager to pay the $20-billion post fee for the lunar race. No single nation other than the two giants can at the moment afford such an impact upon its economy.

But certainly in near-space and in the field of nuclear-tipped missiles, the two big powers within a relatively brief time may find themselves challenged. Other nations are realizing that here lies the technology of the future and are pressing ahead in an effort to keep pace as best they can with the growing technical knowledge of their more richly endowed neighbors.

Initially, this impact is coming in the field of missiles, at least so far as either of the two great powers may consider the development as a threat. The Russians, on the one hand, find themselves concerned with the potential armed might of a West Germany and a France equipped with nuclear-tipped medium-range ballistic missiles, particularly if such a force should exist outside of the restraints of a NATO alliance.

This threat, insofar as Germany is concerned, exists largely in the minds of the Soviets—at the moment. What the situation will be in, say, five to ten years is another matter. In the case of France, General de Gaulle has made it plain that he would prefer an independent nuclear deterrent as soon as one can be developed.

On the other hand, the U.S. must concern itself with the possible development of nuclear missiles by the Chinese—a threat not entirely lost upon the Russians.

This spectre of other nations possessing nuclear missiles is one of the pressing motives behind the nuclear test ban treaty talks in Moscow. It remains to be seen whether the Soviets can convince the Chinese and the Americans can convince the French that such a test ban should be worldwide.

The possibility that, if nothing else, public opinion will be strong enough to enforce it is sufficient to drive both the U.S. and the Soviet Union into hazarding their own antimissile missile developments.

WE BRING all this up because the hardware accomplishments of this industry have been so successful and so extensive that they are becoming a dominant factor in the political field. Because of this very impact, political decisions will play a significant role in future developments and future markets.

In the past, U.S. firms largely have been able to govern their business decisions solely by the U.S. military stature. With the spread of technology, the U.S. is no longer acting unilaterally in this field. The successful firm must be prepared to make some shrewd political guesses before betting its future on hardware developments.

As an example, consider the *Mobile Medium Range Ballistic Missile*. Any effort to determine the future market for the *MMRBM* must now be considered in the light of the ability of NATO nations to develop such a missile for themselves. The U.S. market itself for the *MMRBM* must be judged in the light of Administration intentions if it appears certain that one or more of the European nations are prepared to go ahead with such a weapon on their own.

The *MMRBM* already has been serving as a deterrent. The very fact of the program's existence has made European nations somewhat reluctant to embark on such a project. All of this must be taken into consideration by the firm intending to devote a major portion of its time and talent to the *MMRBM* program.

Nor are such uncertainties limited to the missile field. With the growing capability of other nations in the space field, U.S. companies must crank a new factor into their consideration of world markets.

If it becomes relatively inexpensive to lob satellites into space, the potential U.S. monopoly in communications satellites can be challenged by other nations. Again, ComSat Corp. and other firms interested in comsat technology must be prepared to consider a world where other countries may be interested in something other than the purchase of a ground station.

As an industry, we no longer are an island. Our future plans must be laid accordingly. That is the message behind the extensive pages of this seventh annual encyclopedia issue.

William J. Coughlin

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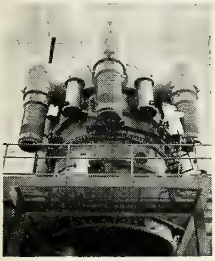

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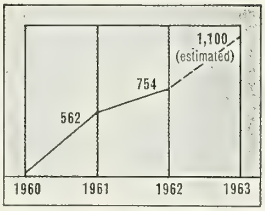

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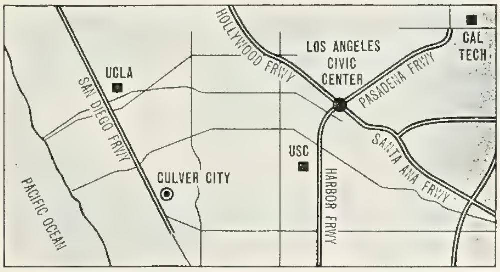

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AUGUST 1963

missiles and rockets

E WEEKLY OF SPACE SYSTEMS ENGINEERING

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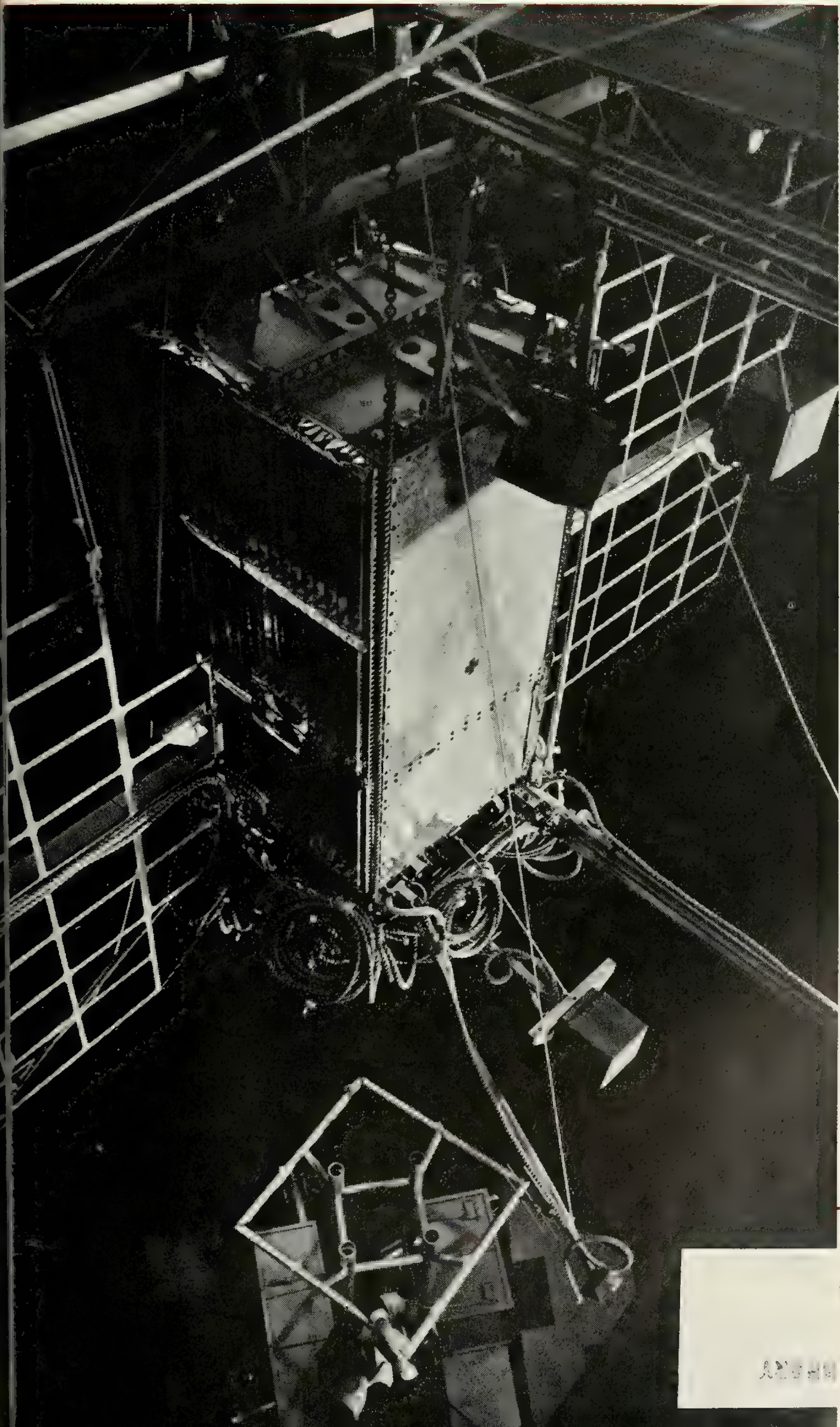


Congress May Create Military Arm For NASA

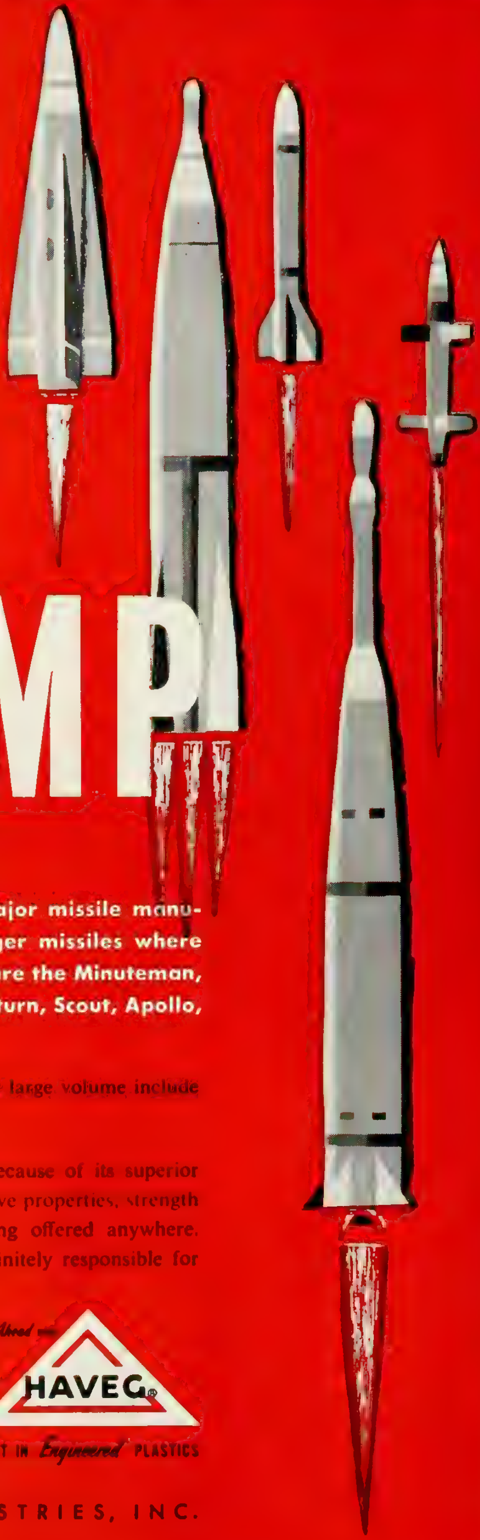
Laser Test Set for S-66

Germans Plan First Satellite

New Apollo Optics Proposed

OGO *in* STL *Chamber*

SIL-TEMP



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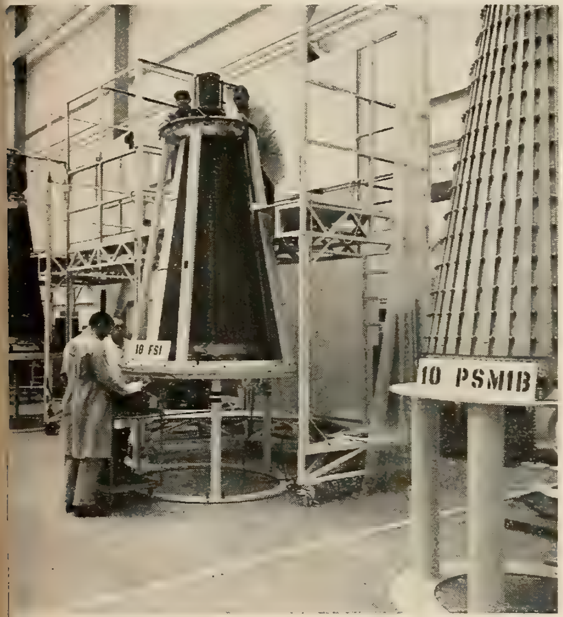

abrication of SNAP 10A systems at A.I.

tomics International is a prime contractor for SNAP nuclear eactor systems for the U.S. Atomic Energy Commission. Respon-ibilities of the company include the entire SNAP 10A and NAP 2 systems, as well as the reactor for SNAP 8. These power ources are designed to generate from 500 to 35,000 watts of lectricity for a one-year period of unattended operation in pace. Already several A.I. SNAP reactors have successfully assed their initial ground operating tests.

or the National Aeronautics and Space Administration, A.I. is tudying the uses of compact nuclear power sources on the noon. To be determined: what design modifications would fit NAP 2 and SNAP 10A for powering instruments and com-nunications equipment on the lunar surface? Also, how could NAP 8 be adapted to the power needs of a manned lunar ase? SNAP applications might include lunar communications tations capable of operating for long periods unattended... erhaps a manned lunar experimental laboratory or astro-omical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

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DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. H. Newton
Personnel Office, Atomics International
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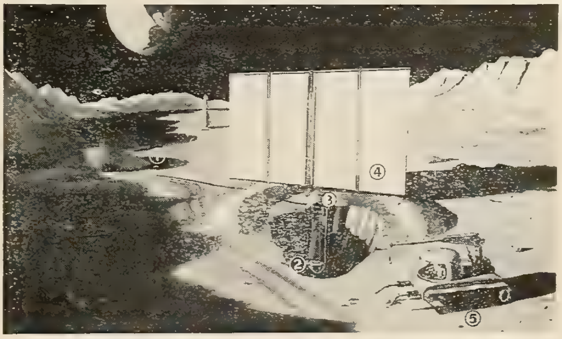

Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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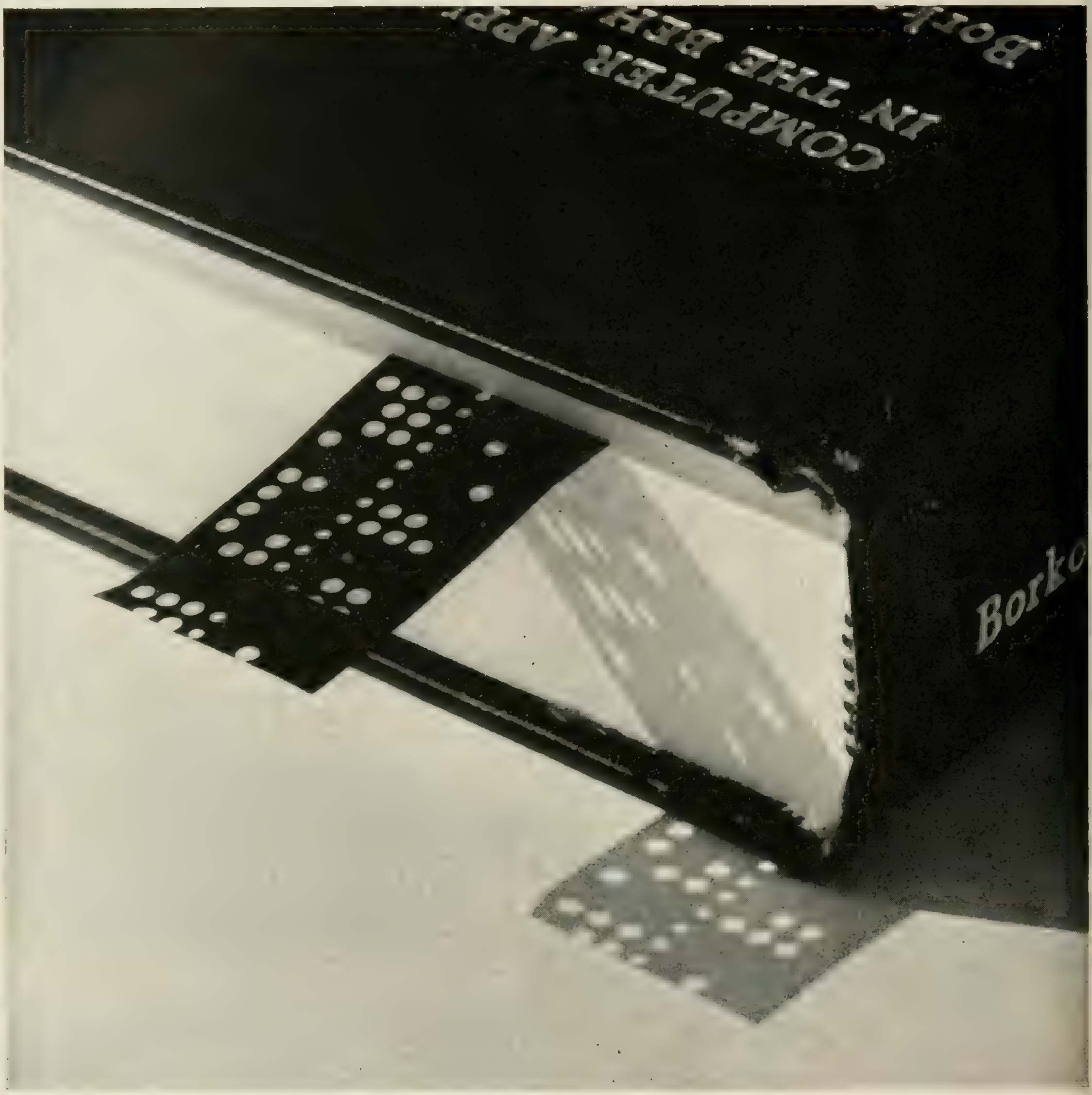

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 13, Number 6 August 5, 1963

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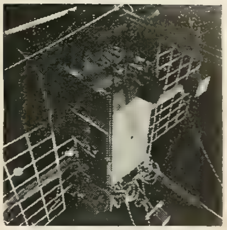

Space Technology Laboratories' 30-ft. space chamber simulates altitudes up to 200 miles (10^{-7} torr) and temperatures from —320 to 400°F. Chamber is part of extensive STL facility for environmental testing of NASA's Orbiting Geophysical Observatory (right) and other satellites.

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letters

To the Moon with Handicaps

To the Editor:

I have just had the opportunity to read your June 17 editorial, "An American Tragedy." I am concerned with the general tone of sympathy for D. Brainerd Holmes' resignation. It seems to me that a broader understanding of the fact that there are limits to everything, even desirable programs like the *Apollo* program, would serve our country better than a constant drumming for more defense and space money. The greatest artists, the best managers, and all of us ordinary people must learn to work within limits and sometimes with reduced budgets. This is life. I find it very difficult to shed tears over a House Space Committee which "has hacked the *Apollo* budget by some 9-10% for Fiscal 1964."

Somehow the whole idea in public life these days is to say if I can't have my way I'll be like the little girl who takes her dollies and runs home. My personal feeling is that Mr. Holmes would be better remembered and accomplish more by keeping his program in line and getting us to the Moon with the handicaps included. This used to be the American way.

Fred Dunlap
Yellow Springs, Ohio

Selling Space

To the Editor:

A comment or two on your space benefit editorial of July 15. Every large educational or public relations program similar to the one you are suggesting, to sell the benefits and objectives of a national program to the public, uses massive amounts of time, talent and money.

And time is short.

The logical group to assume the responsibility is the one which will benefit most from the program—Aerospace Industries Assn.—because it is already organized, has or should have a public relations committee, and employs an experienced aerospace public relations counseling firm.

Every one of these large-scale national programs to which I have been exposed in recent years— from highways to housing—takes months to get organized, to get a budget and public relations/advertising agency approved, and the many other details so necessary to create a hard-hitting, continuous program.

Why not get the North Americans, Boeings, Martins and other members of AIA to contribute to a special "Operation: Aerospace" fund, with specific portions of it delegated for public relations and advertising programs aimed at the general public and thought leaders?

Possibly the primes could get their many subs to contribute a portion also, since it is also to their interest that the American people understand the "feedback" and benefits to be or already being utilized by industry for the consumer.

A starting point might be spreading the word on NASA's Technology Utilization program. The Magazine Publishers Assn., Associated Business Publications, National Business Publications, Public Relations Society of America, and the Association of Industrial Advertisers also should take part, due to their intimate connection with the aerospace industry.

I advocate use of presently-existing groups who can expand their programs, instead of creating another "organization of organizations."

Compton S. Jones
President
Compton Jones Associates
Washington, D.C.

To the Editor:

Your July 15 editorial on the need to publicize our bloated space effort invokes the nation's "interest" and "benefit" no less than four times. The real point of the editorial, however, is your appeal to the industry's self-interest. As with the nation's arms program, atomic energy and farm subsidies, the space program has spawned such a vast industrial complex that any cutback would be likely to cause chaos.

So let's not be cynical about it: the nation's interest would be served by a realignment of NASA's space program. But industry's vested interest (and, lest we forget, that of your magazine) demands that we pump more and more dollars into it.

Carl Goldstein
East Orange, N.J.

To the Editor:

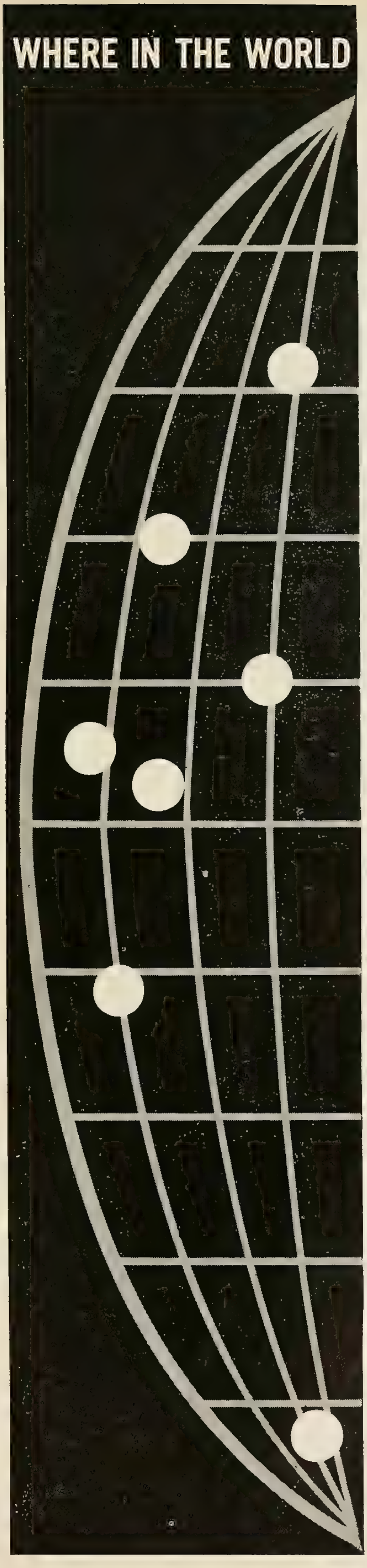
I found upon reading over your editorial a couple of times that my opinion somewhat differs from yours, in that if 40% of the presidents of various corporations were replaced, the security and integrity of the working man or layman would be brightened.

Too many times the president has beneath him men who don't know their responsibilities, but are kept on the payroll as department heads because they can tell good jokes, or because of religious beliefs. When the director of engineering, a very bright boy, can't see this, or in some cases, tolerates it, I say the president, to whom the director reports, should take drastic measures.

The job of being president of a corporation is not an easy one. The president should have beneath him energetic men with drive. I strongly feel that a president is as good as his fellow employees make him. It's very similar to a halfback who makes long yardage but couldn't do it without the line in front of him, working with him (not against, no room for empire builders), making a hole to go through.

I am 100% behind you in your statement, "to educate the American people on the benefits and objectives of the national space program—and to keep them well-informed." Your editorial shows a lot of thought and organization. If some presidents thought along these lines, I believe the layoff and reduction in personnel could be curtailed.

R. E. Manning
North Hollywood, Calif.



WHERE IN THE WORLD ARE THE NAVAL LABORATORIES IN CALIFORNIA?

Physically, the U. S. Naval Laboratories in California are headquartered in California, which is no surprise. However, this is only part of the story . . . for, in a sense, their activities extend throughout the world. For instance, scientists and engineers from the laboratories work in such far-flung and divergent areas as Eniwetok, the Union of South Africa, Alaska, Australia and Hawaii, to name a few.

Laboratory personnel and facilities also occupy missile/satellite tracking ships in the Indian Ocean, participate in Operation Deep Freeze in the Antarctic, operate radar sites in Japan and probe the deep water secrets of, for example, the Mariannas Trench in the Phillipines.

The extensive global activities of the Naval Laboratories in California match the collective and individual capabilities of each facility. Typical activities could involve, for example, oceanography studies (NEL); launching and tracking a Discoverer type satellite (PMR); arctic snow/ice research (NCEL); fleet ordnance development (NOTS); missile firing evaluation (NOLC); and nuclear radiation studies (NRDL).

Whether your scientific/technical interests are stimulated by working in a mainland laboratory or participating in a specialized research project in the distant tropics or the arctic, the U. S. Naval Laboratories in California offer a maximum challenge. Qualified scientists, engineers, and technicians who wish to explore employment opportunities at any of the laboratories listed below are invited to contact the Personnel Director, Dept. E, at the facility of their choice.

U. S. Navy Electronics Laboratory (NEL), San Diego

Pacific Missile Range (PMR) and U. S. Naval Missile Center (NMC), Point Mugu

U. S. Naval Civil Engineering Laboratory (NCEL), Port Hueneme

U. S. Naval Ordnance Test Station (NOTS), China Lake and Pasadena

U. S. Naval Ordnance Laboratory (NOLC), Corona

U. S. Naval Radiological Defense Laboratory (NRDL), San Francisco

U. S. Naval Personnel Research Activity (NPRA), San Diego

U. S. Naval Weapons Station, Quality Evaluation Laboratory (QEL), Concord

All qualified applicants will be considered for employment without regard to race, creed, color, sex, or national origin.

U. S. NAVAL LABORATORIES IN CALIFORNIA

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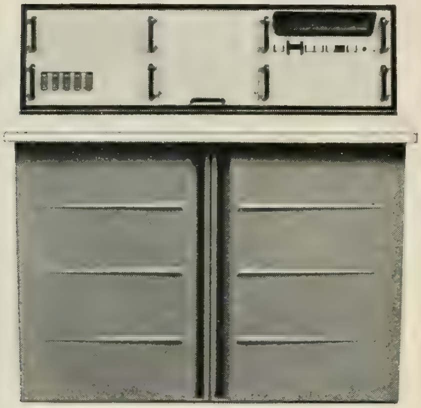

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SYSTEMS SUPPORT DEPARTMENT, ANAHEIM, CALIF.

The Countdown

WASHINGTON

Big Solids Still Kicking

Government officials now believe there's a 50-50 chance that the big solid motor program will be saved from Defense Secretary McNamara's budget-cutting shears. New optimism is based on the vigor of powerful Congressional advocates of the program—among them Sen. Richard B. Russell (D-Ga.) and Chairman George Miller (D-Calif.), of the House Space Committee. Final decision as to how much—if any—of the Fiscal '64 funding will be trimmed may come in a few weeks. NASA last week submitted to DOD its official position opposing any reduction.

MPLE Development Year Away

The budget in FY 1965 is expected to include first funding toward purchase of Multiple-Purpose Long-Endurance aircraft (MPLE), popularly called Project Maple. Planes will have regenerative engines and carry missiles, serving as a sort of *Polaris* sub of the air. A big buy of both aircraft and missiles is anticipated.

Haney Taking Over from Powers

Paul Haney, public affairs officer for NASA's Office of Manned Space Flight, has been selected to succeed Lt. Col. John ("Shorty") Powers as public affairs officer at the Manned Spacecraft Center. Powers, an Air Force officer long famous as the "Voice of *Mercury* Control," is expected to leave government service for a job in private industry. His departure follows what Administrator James E. Webb felt were too many public statements that ran counter to official NASA policy.

TAD Announcement Imminent

Goddard Space Flight Center is expected to announce shortly its decision on whether to buy the *Thrust-Augmented Delta* (*TAD*) for its booster stable. An affirmative choice is likely. It's not known yet how many of the Douglas vehicles NASA might use, or what experiments they would carry.

Apollo Gathers Itself at Cape

The first *Apollo* spacecraft components—a launch escape motor and a pitch control motor—were recently delivered to NASA at Cape Canaveral. They will be followed later this year by an *Apollo* boilerplate spacecraft including the command and service modules, and the remainder of the launch escape system. Together, the components will make up the *Apollo* scheduled for launch in 1964.

House Set to Finish NASA Cuts

The House of Representatives was expected to approve NASA's Fiscal '64 authorization bill following debate last week. It was also expected to go along with the House Space Committee's almost $500-million slash in the total, leaving $5.2 billion. Only uncertainty as debate neared was whether the House would go along with a move by the Republican Policy Committee to make an additional $35-million request, split between the educational grants and advanced design development programs.

INDUSTRY

Space-General To Plan Moon Craft

Space-General Corp. has been picked to study the lunar probe which would be launched from an orbiting *Apollo* to the surface of the Moon. No firm has yet been chosen for a proposed *Apollo* reconnaissance module which would be used to take pictures of the lunar surface.

White Sands Bids Due Soon

NASA's Manned Spacecraft Center has asked industry for bids on a contract for maintenance and support of its White Sands, N.M., Missile Site. Bids are due Aug. 19. In another procurement action, the center has asked firms to submit proposals by Aug. 22 on a study of a deep-space antenna system. Study will be worth about $50,000 and last six months.

'Instant L/D' Rocket for M-2

Small solid rockets in the *M-2* lifting body glider at NASA Flight Research Center will help test-pilots recover from dangerous landing approaches. Wingless *M-2* shape has poor lift/drag ratio, compared with conventional aircraft; hence, a steep glide angle that makes the flare-out for landing a tricky maneuver. Nicknamed "Instant L/D," the rocket enables the pilot to add power to flatten his final descent just before touch-down. The 200-lb.-thrust rocket burns for 10.5 sec. and increases the glider's effective L/D from 3.0 to 6.5. Rockets are cheap propellant batch-test motors donated by neighboring Naval Ordnance Test Station, China Lake, Calif. The unique "jet-assisted landing" rockets will be evaluated in a high-speed taxi test before being used in flight to make sure there is no problem due to thrust misalignment.

LH_2 Rocket Passes Throttle Tests

A liquid hydrogen-fueled rocket has been successfully throttle-controlled in recent tests at the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. In the half-dozen runs made, a spark plug was used for ignition and a maximum thrust of about 20,000 lbs. was developed.

INTERNATIONAL

Dutch Navy Orders Seacats

Four Leander-class frigates now being built for the Royal Netherlands Navy will each be armed with two *Seacat* launchers. Cooperating with the British *Seacat* manufacturer, Short Brothers and Harland Ltd., of Belfast, will be Signaal Apparaten, the same Dutch company that supplied radar direction equipment for Sweden's *Seacat* trials.

France to Develop Own Tracking Network

In the French supplemental appropriations for 1963, $13,360,000 is earmarked for space research. This includes $2.8 million as a new contribution to the *Diamant* satellite booster program. France now plans to establish its own tracking network, which will later be integrated in the European network. The French net will include one station in the Canary Islands, one in South Africa, and four telemetering stations in Africa.

The Missile/Space Week

DOD Reviews Rating Plan

The new NASA-DOD Contractor Performance Evaluation System—which could lead to an official blacklist of missile/space contractors—was submitted to Secretary of Defense Robert S. McNamara last week.

His approval and implementation of the system is expected in the near future.

Once it is obtained, a DOD official said, it will be applied across the board on all engineering development and operations system development contracts costing $5 million or more in one year or at least $20 million over the life of the contract.

The system provides that project officers will evaluate contractor performance against contract requirements in the areas of scheduling, cost and technical achievement. The evaluation will be made every six months with a final report at the completion of the award. This report—which will be supplied to the contractor for his own comments—will then be made available to source evaluation boards during future contractor selection proceedings.

While it will be applied across the board at DOD, a NASA official said the space agency will probably test the system first on one prime contract.

Walter Sohier, deputy NASA counsel, said the test case will be initiated as soon as the system is approved at DOD. Later, it is expected that the system will be made available to any government agency wishing to use it.

AF Recovering Capsules

Aerial recovery of space capsules ejected from secret orbiting satellites has become routine for the 6593rd Test Squadron operating from Hickam AFB, Honolulu.

The unit has successfully retrieved 70% of the capsules ejected from polar satellites orbited from Vandenberg AFB, Calif.

Details of the squadron's success were released when it received the "Outstanding Unit Award" for "Its record in the development and application of aerial techniques for the recovery of space capsules returned from orbiting satellites."

Vandenberg's polar satellites are generally assumed to be on reconnaissance missions. Ejected capsules, carrying photographic or other records, parachute down over the Pacific after re-entry. The 6593rd's routine consists of "snaring" the parachute and hauling it in—before it reaches sea level.

The first recovery of a capsule from space was carried out in August, 1960. Ejected from the AF *Discoverer 13* satellite, that capsule was fished out of the Pacific by Navy divers. Since then 78 satellites have been put into orbit from Vandenberg.

Rocket Engine Makes F-104 a Re-entry Trainer

AN AR-2 ROCKET engine delivering 6,000 lbs. thrust has made a re-entry trainer out of Lockheed-California Co.'s F-104. With the double-barrelled propulsion system (including the Starfighter's regular J-79 jet engine) the NF-104A can reach altitudes between 120,000 and 130,000 ft. Three of the craft will be delivered to the Aerospace Research Pilot School at Edwards Air Force Base, Calif. Pilots will use the NF-104A for training in zero-g flight and atmosphere re-entry, among other things. The AR-2 engine, built by Rocketdyne Div., North American Aviation, Inc., will take over when low air density reduces effectiveness of the regular jet engine.

Shots of the Week

An Air Force *Blue Scout Jr.* boosted a 50-lb. spacecraft from Cape Canaveral July 30 in an 8,000-mi.-high arc to study space beyond limits of the F layer of the ionosphere.

The instrumented spacecraft used extendable, 30-ft. antennas to measure background space noises in the 2.4- and 4-mc bands. It also measured intensity of the radiation field. First checks indicated that the experiment was working satisfactorily.

At least seven more *Blue Scout Jr.'s* are now scheduled for launches from the Cape. Future payloads are to include at least one to study Earth's magnetic field out to 22,000 miles, and several to study cosmic radiation at altitudes to 10,000 miles.

Other shots of the week:

- *Syncom-II* was carried into space July 26 by a *Delta* rocket (see p. 17). The satellite, fired from Cape Canaveral by NASA, is to serve as a relatively stationary (orbits synchronized with Earth's rotation) communications aid.
- A Strategic Air Command crew launched an *Atlas-E* ICBM more than 7,000 miles into the Pacific Missile Range from Vandenberg AFB, Calif., July 30.
- An Air Force *Thor-Agena* was fired from Vandenberg AFB, Calif., July 30. *Thor-Agena* is used by the Air Force in the *Discoverer* program
- A *Minuteman* solid-fueled "instant" ICBM was fired July 27 at Vandenberg AFB, Calif.
- An *Atlas-D* ICBM was launched by the Air Force from Vandenberg AFB, Calif., July 26.
- Also from Cape Canaveral on July 26, the Navy successfully launched a *Polaris A3* to test basic design and performance.
- The Air Force successfully fired a Wing II *Minuteman* about 2,000 miles from Cape Canaveral on July 24 in a short range test.

Kavanau Joins NAA

Dr. Lawrence Kavanau, former special assistant for space to Defense Dept. research chief Dr. Harold Brown, is joining North American Aviation, Inc.

He will be an executive vice president in the Space and Information Systems Division.

Mueller Outlines Philosophy

Dr. George E. Mueller, NASA's new deputy associate administrator for Manned Space Flight, (M/R, July 29, p. 19), has been variously described by associates as imperturbable, stubborn, impatient, a dynamo and a man who believes in being personally on the spot to solve problems.

Mueller doesn't deny having been all of these things at some time, but he told MISSILES AND ROCKETS that these comments do not truly describe the kind of manager he is.

Mueller will take his new post Sept. 1 after resigning as vice president for research and development at Space Technology Laboratories.

He says he hesitates to "even think of changing the management structure of a program that has produced such spectacular successes as *Mercury* and *Saturn*."

Mueller says he believes this about the manned spaceflight program: "There are no insurmountable problems in our getting to the Moon. *Apollo* is not a dead-end program. This is the first of a family of large boosters and large spacecraft. . . .

"I feel that the real national objective is pre-eminence in space, not a single-shot victory or a space spectacular. We have a broad-based, solid space program."

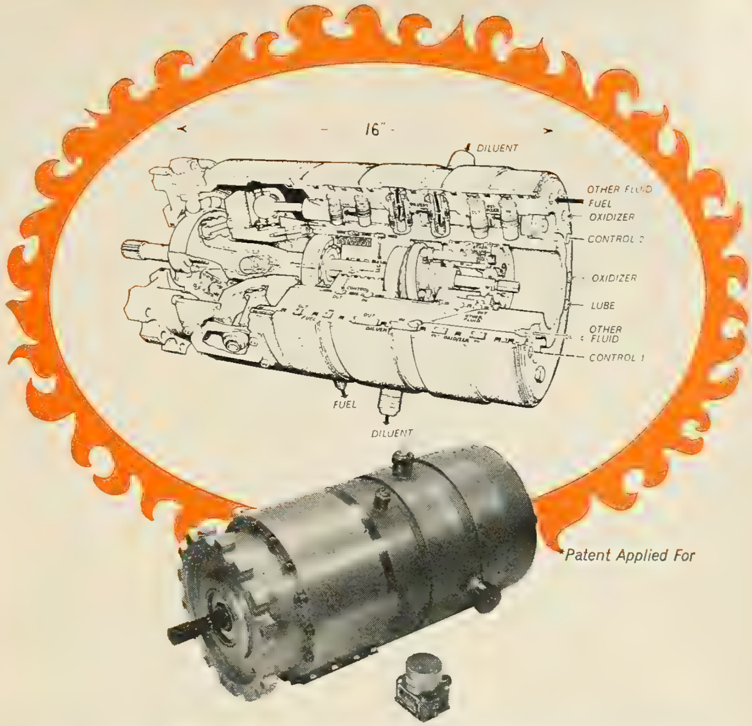
Regarding the NASA chain-of-command, Mueller says "I'm working for Dr. Seamans, Mr. Webb and Dr. Dryden. There are clear lines of responsibility and authority."

MSFC Asks LH_2 Bids

Marshall Space Flight Center has asked 45 industrial firms to submit bids on providing liquid hydrogen for use at the Marshall Center and Mississippi Test Operations.

Current estimates of the amount of liquid hydrogen which will be required between April 1, 1965, and December, 1970, total 78.28 million lbs. at a cost of about $37 million.

Liquid hydrogen will be used at MSFC in tests of the S-IVB stage of the *Saturn IB* and *V* space rockets and at MTO in tests of the S-II stage of the *Saturn V* Moon rocket. Both stages are powered by J-2 engines



*Patent Applied For

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The pump contains five one-piece pistons with three stepped diameters (see sketch) and displacement is controlled by varying the swashplate angle with an electro-hydraulic servo valve (pictured).

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burning liquid hydrogen and liquid oxygen.

Award of a contract, expected about December, will result in construction of a storage facility within 50 navigable miles of MTO, and a new liquid hydrogen manufacturing plant situated at the contractor's discretion.

Terms of the contract will specify that the contractor, in addition to building and operating the plant, will build and operate the storage facility for liquid hydrogen and liquid oxygen. The government will procure liquid oxygen through formal advertising and store it at the facility near MTO.

Bidders are asked to submit two bids, one for a 30-ton-per-day production capacity plant and one for a 20-ton-per-day plant which could be converted quickly to a 30-ton capacity if necessary.

PMR Contract Awarded

Western Electric Co. has received a $6,197,000 contract from the Navy for development of a new Pacific Missile Range telecommunications system.

The system will provide multiple countdown capabilities, enabling the control center to switch range safety and control communications from one pad to another electronically. A manual disconnect system is now used.

Completion of the design phase is expected in April, 1964.

Phase 2 includes engineering, fabrication and installation of the system in the Pt. Mugu/Vandenberg AFB area, and Phase 3 will encompass installation of a similar complex at Pt. Mugu/San Nicolas Island.

Ex-Westinghouse Head Dies

Mark W. Cresap, Jr., 53, died July 28 in Pittsburgh, less than two weeks after resigning as president and chief executive officer of Westinghouse Electric Corp. because of poor health.

He had been succeeded by Donald C. Burnham, formerly vice president in charge of the company's industrial group.

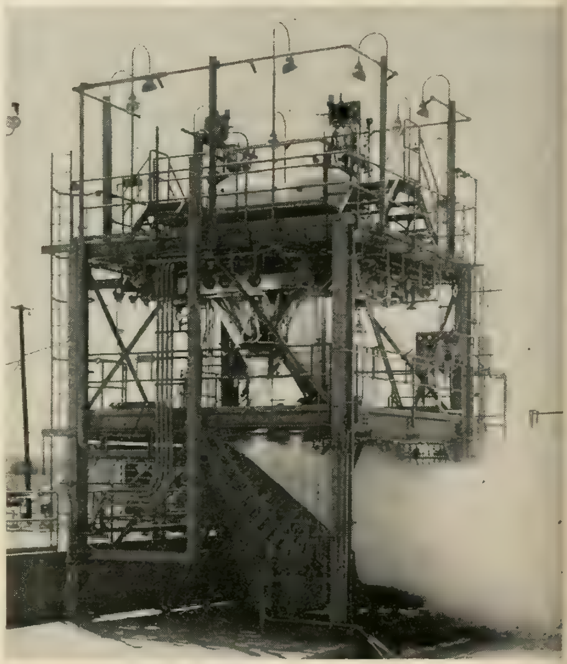
ARC To Build New Rockets

Atlantic Research Corp. has received a $2.5-million contract from the Air Force's Rocket Propulsion Laboratory, Edwards AFB, Calif.

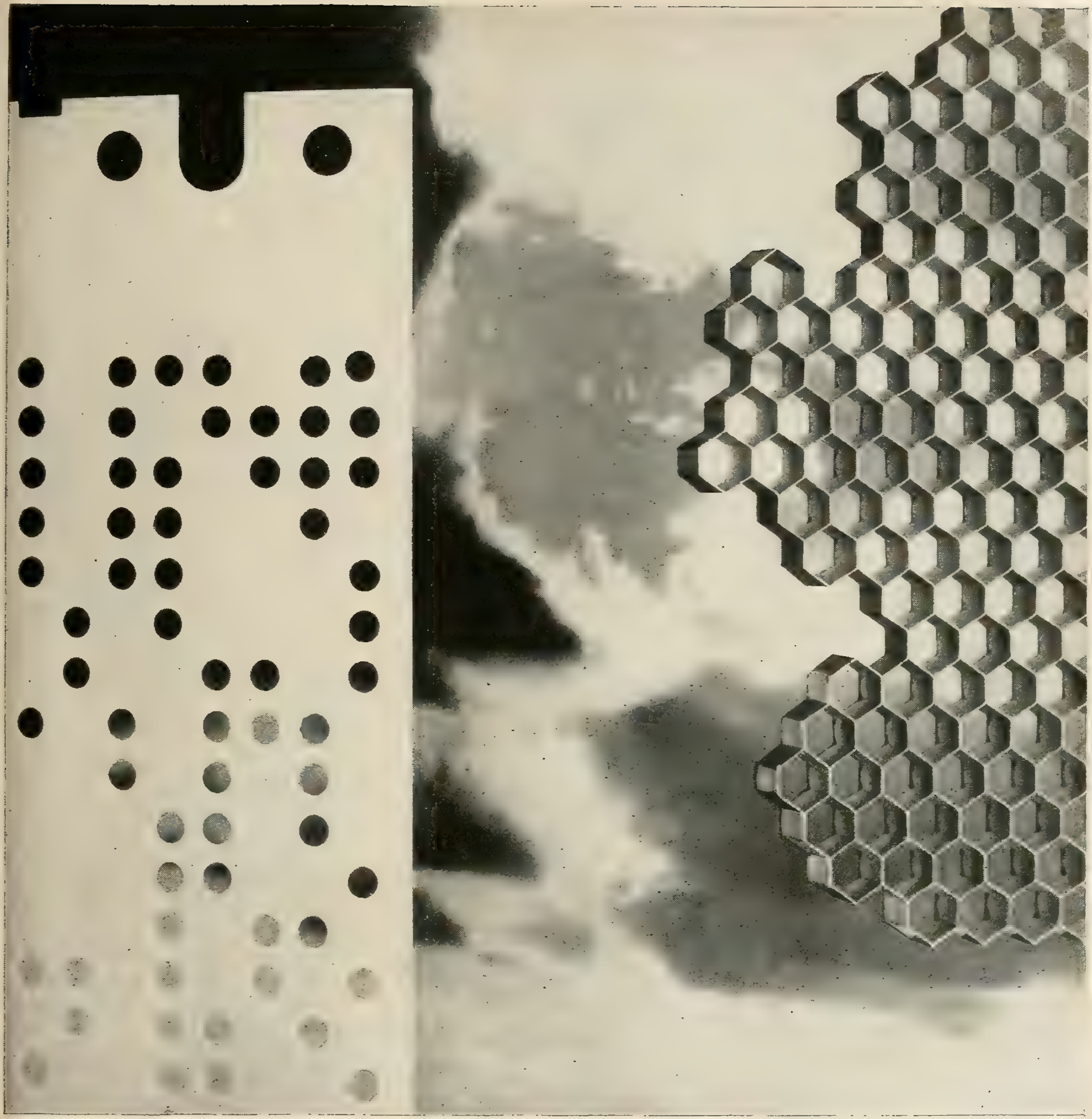
The contract calls for design, fabrication and static testing of "very high performance" experimental solid rocket motors, plus delivery of two flight-weight prototypes.

Work is to begin immediately, with delivery of the prototypes due within 20 months. Engineering and development work will be performed in ARC's principal laboratories near Alexandria, Va.

Titan III Transtage Fired



AIR FORCE Titan III Transtage engines are fired at Aerojet-General Corp. Sacramento, Calif., plant (M/R, July 29, p. 19). Transtage ablative chambers have withstood nearly nine minutes of hot tests, longer than required for the flight version.



Program for a mission, pattern for a launcher

Punched cards and aluminum honeycomb played an important part in the development of an advanced ECM simulator, and production of a lightweight launcher for ASROC. While the design problems were different, they were solved by a similar capability—engineering skill and ingenuity offered by Universal Match Corporation's Government Products Group.

A simple punched-card system provides a flexible method for programming the T-4 Electronics Countermeasures Simulator, developed by Reflectone Electronics, Inc., a UMC subsidiary: T-4 can duplicate virtually any RF condition which a B-52 ECM officer might encounter over enemy territory.

Engineers at UMC's Unidynamics Division combined light weight and high strength needed for ASROC's unique launcher through use of honeycombed aluminum. The unit not only nests eight missiles above deck, but also serves as launcher. This imaginative design technique points the way toward more reliable launchers of increased mobility.

UMC's Government Products Group offers the capability for solving many diverse problems, and the ability to design and produce advanced systems important to our defense posture.

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House hearings planned . . .

NASA May Get a Military Arm

Congressional committee suggests new division may be needed to develop defense applications; report hits at duplication

by Heather M. David

CONGRESS MAY be asked to enact legislation this session to provide for a new arm of NASA to deal with military space applications.

In a unanimous report, the House Science and Astronautics Committee indicated it may be necessary to create a new NASA division "directly charged with responsibility for uncovering and developing military applications from civil space techniques as these evolve." The committee suggested it could be organized like the military applications division of the Atomic Energy Commission, which has been functioning for several years.

Chairman George P. Miller (D-Calif.) said the committee will schedule hearings on the questions of agencies' roles in the space program after the authorization bill (HR 7500) makes its way through the House. Miller also said that a committee staff member will be assigned to investigate the subject. Rep. Walter Riehlman (R-N.Y.) told MISSILES AND ROCKETS that if the investigation does not prove that the NASA-military relationship is satisfactory, a bill to create a special NASA division will be the next step.

The idea of creating a military division in NASA is not new. A similar bill to amend the Space Act was passed by the House in 1960. The Senate did not act upon the amendment at that time. However, increasing concern for the military space program has been voiced by such influential Senate leaders as Barry Goldwater (R-Ariz.) and Margaret Chase Smith (R-Maine).

Another Republican, Rep. Donald Rumsfeld (Ill.) said he was introducing a bill to set up a special House committee, composed of members of the House Armed Services Committee and the Space Committee, to question the entire logic of the nation's space goals. Five other minority members joined him in a statement detailing in strong language their concern over the lack of a defined military space program.

The Republican members stated that the current approach to space ignores the main thrust of the Soviet space aim, "which is to dominate inner space through the ability to exercise control over the surface of the Earth." They said the crux of the problem is the control of the area of space surrounding the Earth to a distance of 100 to 500 miles.

• **Duplication hit**—The committee unanimously scored the lack of coordination between agencies, which it said was evident during all the hearings. Specifically it named the *Apollo* tracking ships, research in aerospace medicine, construction of a meteorological laboratory, research in life sciences and in long-range planning for manned spaceflight and in equipment integration and checkout functions.

The committee particularly suggested that NASA utilize as much as possible the computer-communications network and re-entry facilities the Air Force is establishing at three sites in the western U.S. (M/R, June 10, p. 34; July 8, p. 14). The report indicated that NASA will find it hard to justify future fund requests for new computer facilities in the light of the Air Force decision.

The minority report also singled out aerospace medicine as an area of duplication. It proposed that the $4.6 million asked for Ames Research Center for a life sciences research laboratory be deleted and, instead, that $2 million be used to expand military facilities at Wright-Patterson Field or Brooks AFB.

• **Big boosters**—Chairman Miller said he still has not scheduled a meeting with Secretary of Defense Robert S. McNamara on the subject of big boosters, but will do so soon. He reported that if the committee finds that DOD is curtailing its funds for this project, it may make a recommendation to the Space Council that NASA take over the program. He added that this would take a Presidential recommendation. The committee report also urged acceleration of research into high-energy chemical fuels, such as boron, diborane and fluorine compounds.

• **Comsat Corp.**—Rep. William F. Ryan (D-N.Y.) in a separate report recommended that Congress demand reimbursement from the Communications Satellite Corp. He said the corporation's strategy "seems to be to let the Department of Defense do the work for an operational medium-altitude system, and to let NASA do the research for a high-altitude system."

The minority report urged further cuts of $35 million in the NASA budget, already $490 million less than the Administration request. Amendments from these members are expected to be proposed on the House floor to reduce the educational grants request from $55 million to $30.6 million, and advance design development funds from $25 million to $15 million. The Republican Policy Committee also voted to support this portion of the minority views. ■

Senate To Soften Blows

THE SENATE will be ready to act quickly on the NASA budget as soon as it passes the House. The Senate Space Committee bill is expected to call for restoring about $200 million of the $490 million cut by the House.

One cut the Senate may make, which would differ from the House bill, is in the $5 million asked for the Boston Electronics Center. The House bill would give the agency $3.9 million upon receipt of a NASA study to be conducted in January, but the Senate has considered cutting funds completely.

The Center will face stiff action on the House floor as well. The House Republican Policy Committee has voted to support an amendment withholding funds for the center until the NASA report is made to the entire Congress.

The Senate probably will restore all *Apollo* spacecraft funds ($120 million), part or all of related items for manned spacecraft ($30 million for M-1, $5 million for aerospace medicine, and $28 million for integration and checkout). *Surveyor Orbiter* funds ($30 million), *Rover* ($5 million) and communications satellites ($9 million) probably will be largely or completely restored.

MMRBM Guidance, C&C May Go On

Harold Brown fails in fight for full-speed development; GPI, Martin, Sylvania retain assignments but other companies are losing out

GUIDANCE, command and control aspects of the Air Force's *Mobile Medium-Range Ballistic Missile (MMRBM)* probably will continue to be funded despite the fact that the parent weapon system faces cancellation.

Although no official announcement had been made as of late last week, all indications pointed to the demise of the *MMRBM*. First hint of the cancellation came when Defense Secretary Robert S. McNamara refused to protest a $100-million cut in the program's funds by the House Committee on Military Appropriations.

This lack of protest in his letter to the Senate committee considering the bill was interpreted to mean the *MMRBM* is dead.

• **Brown overruled**—The cancellation is in direct opposition to the position taken by Dr. Harold Brown, Director, Defense Research and Engineering, in his testimony before a House subcommittee last May. Brown said in effect that there would be a good chance for full-scale development of the weapons system by July or August of this year. He went on to deplore the possibility of a Congressional cut in the program funds. Yet the Committee left only $43 million of the $143 million total requested.

At the time, Brown stated that McNamara "has decided to have an *MMRBM* program" but "what its nature shall be is still not clear."

Indications are that DOD intends to pursue the guidance, command and control systems section of the *MMRBM*, since these would have applications in other military and space projects.

This decision leaves General Precision, Inc., in the clear with $37 million in funds for the development of the guidance and control. The firm had the contract for program definition in this area. The system itself is still highly classified, but it is known to be a stellar-inertial guidance type—a star tracking system on a three-gyro platform.

Martin Marietta Co. in conjunction with Sylvania Electric Products Inc., subsidiary of General Telephone and Electronics Corp. will also continue the development of the command and control system. Neither effort will be directly associated with *MMRBM* as a weapons system.

• **Out in the cold**—Thus, of the six categories of program definition, the four solely related to *MMRBM* as a specific weapon will be cancelled. Firms and categories involved include: Hughes Aircraft Co.—integration, assembly and checkout; Ford Motor Co. working with Ford Instrument Division of Sperry Rand and the Stratos Division of Fairchild Stratos Corp.—re-entry system; Thiokol Chemical Corp, Rocket Operations—propulsion; Goodyear Aerospace Corp. Arizona,—transporter launcher.

If the *MMRBM* program had been continued, it would have been strictly a U.S. development, without NATO participation at least in its initial phases. NATO nations have expressed interest in the weapons system as a nuclear solution to Western European defense, but the U.S. has warned that the weapon would not be made available to NATO without a price. This would have been a substantial contribution towards the RDT&E funding tab. ■

Navy Seeks New Ship-Launched System

THE NAVY is calling for program definition proposals for a new ship-launched rocket probe weapons system with multiple payload capabilities.

Dubbed *Sea Star*, the system concept envisions maximum utilization of existing fleet hardware. The *Sea Star* will include a launch vehicle and three separate but interchangeable payloads for communications, weather reconnaissance and electronic warfare experiments.

Other requirements cover associated launching equipment, ground read-out and terminal equipment. Further definition of the concept is classified.

The Navy studied a system with similar goals several years ago but dropped the idea. The then-considered concept would have used existing Navy rocket armament such as the *Tartar, Terrier* and *Talos* missiles together with their associated launching gear.

The idea was to fire these missiles ahead of the fleet with the warheads substituted with instrumentation for checking weather or enemy activity. The plan was to fire the payloads in long, arcing trajectories to photograph the ocean surface, send back weather information, or possibly even detect enemy submarines.

The Navy said responses to the solicitation announcement should be made in duplicate—including scientific and technical personnel, availability of facilities, professional backgrounds, etc;—and be limited to 15 pages. The proposed management approach and capabilities—including program organization, identity of potential subcontractors and PERT-time analysis—is to be included in less than 20 pages. In addition, a five-page preliminary cost estimate and a list of RDT&E facilities is requested.

An industrial clearance of SECRET is required and the submission closing date is August 30. All responses should be made to Chief, BuWeps, Code RTAD-32, Astro-Defense Division, Navy Dept., Washington 25, D.C.

Two contractors will be selected for the program definition phase; one will be chosen as the prime for the actual weapons system development.

MOSS May Get Extra Year's Study

MSC-Houston symposium told that advanced program would be wide open; Center favors large rotating station concept, Langley for small model

by Hal Taylor

HOUSTON—The Manned Spacecraft Center is prepared to move to an advanced study program for the *Manned Orbiting Space Station* project if hardware funding is delayed for another year.

An MSC official told MISSILES AND ROCKETS the extra year could permit, for the first time, the preparation of detailed design and specifications prior to the award of the development contract.

The contracts in the advanced program, the official said, would not be limited to the nine firms now performing *MOSS* study contracts, but would be thrown wide open to missile/space companies.

The official's comments were made as MSC and the Houston Chamber of Commerce held their Second Annual Industry Assistance Symposium. Highlights of the one-day meeting attended by over 1,100 industry representatives included:

—H. B. Cather, director of material for North American Aviation, Inc.'s Space & Information Systems Division, declared that subcontractors wishing to participate in major development programs should make their capabilities known when possible prime contractors are preparing their proposal—not after the prime has been selected. By that time, he said, the primes already have made their "make or buy" decisions and have selected the firms which would be included in the project's industrial team.

—Dave W. Lang, MSC procurement officer, said most of the center's new contracts in Fiscal '64 will be in the area of technical equipment for the laboratories and buildings at the new Clear Lake, Tex., site. Other funds will be spent for guidance and control technology, crew systems, and studies of advanced missions, Lang told a press conference.

In the guidance and control area, current requirements call for the expenditure of $8.5 million, including $2.4 million for an ultimate visual simulator.

About $200,000 will be spent for procurement of small components. The remainder will be needed for generalized laboratory equipment.

—J. C. Snedecker, business manager for Grumman Aircraft Engineering Corp.'s Lunar Excursion Module (LEM) program, said that the firm expected to spend $40 million for subcontractor work in Fiscal '64. He said that while the major subcontractor team has been selected, the first-tier subcontractors are now in the preliminary stage of selecting their own subcontractors.

—Wayne Corbett, MSC procurement, said more and more two-phase source selection can be expected in the center's R&D contracting. The new system calls for submission of technical proposals first. The number of competing firms is then narrowed down and detailed pricing proposals are submitted prior to selection of the final contractor.

• **MOSS Plans**—In discussing the space station project—which probably will be MSC's next big development program—the officials indicated that there appears to be little likelihood of heavy funding in Fiscal '65.

This will mean that NASA will have to delay its current schedule, which calls for selection of the optimized station concept early next year and the award of a preliminary design contract.

Center spokesmen still strongly favor the large rotating space station, which would create artificial gravity for experiments to determine man's ability to survive long interplanetary flights.

Langley Research Center officials oppose the large-station concept. They contend that a small zero-g station holding four to six astronauts could be built earlier and at a cheaper cost.

MSC officials point out, however, that a zero-g station only permits a determination as to whether there will be a weightlessness problem.

They say the rotating station would not only determine the problem, but would enable scientists to perform experiments designed to find a solution.

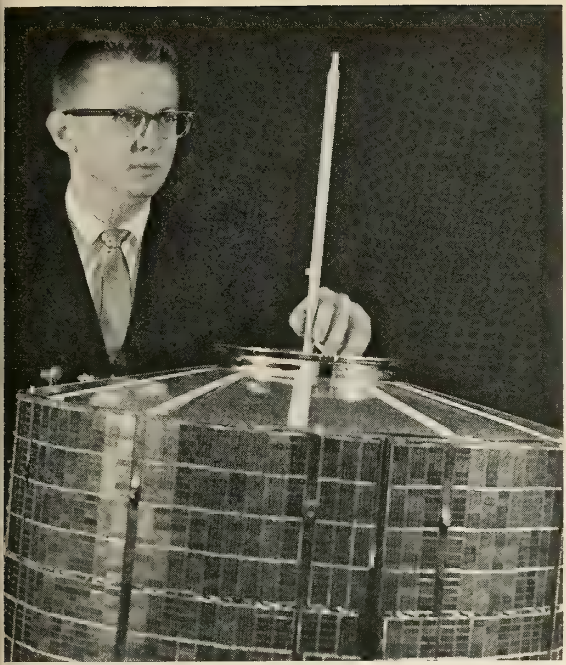
MSC also believes that the large station can be developed just as quickly as a small one—namely, in time for flight before 1970. They admit that it will cost more than the estimated $2.5-billion price for a small station, but do not expect large-station development funding to exceed $5 billion.

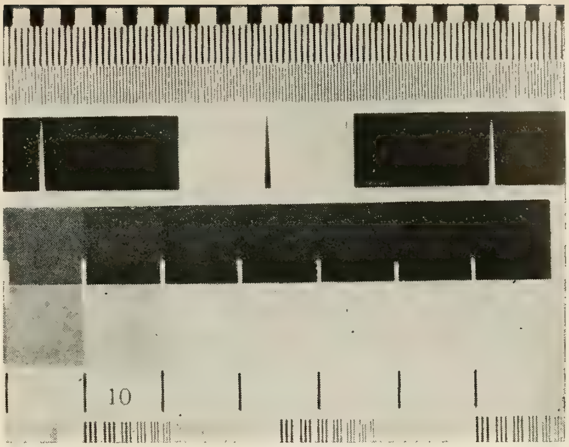
The Kennedy Administration still has not made a decision as to which agency—DOD or NASA—will manage the *MOSS* project. NASA officials at this point are confident they will be selected, but they are pessimistic about any early hardware funding.

Apparently MSC believes that if there is to be a one-year delay in the program the added time should be used to do many of the things usually done by the prime contractor after a contract is awarded.

Rather than selecting one station concept for development, the officials feel, the two best approaches should be chosen for further study. Then a two-phase study program could be initiated. One phase would involve detailed preliminary design of both concepts. The second would be a so-called "architecture" contract attempting to accomplish the preparation of plans and specifications usually done by the prime contractor—and often a major reason for delays in programs. In addition, the second phase could include a decision as to just what a prime contractor must supply to the program.

The advanced study program, MSC officials believe, would lead to the best possible decision as to the station's most feasible configuration. ■





LEFT: *Syncom project manager for Hughes Aircraft Co., C. Gordon Murphey, adjusts spacecraft's antenna prior to launch.* **ABOVE:** *Test pattern returned from satellite to USNS Kingsport anchored at Lagos Harbor, Nigeria, during first test of Syncom II's capabilities to transmit photo facsimiles July 26. Series of lines and shadings determine quality and resolution of the transmission. Size of the image sent to the satellite and received back on the ship was 3½ by 4½ in.*

After three delays . . .

Syncom II in Orbit and Operative

THE SUCCESSFUL *Syncom II* flight is a major step opening the way for development of advanced communication and meteorological satellites.

Two questions have held up a go-ahead for satellite programs—such as the *Advanced Synchronous Communication Satellite* and the *Synchronous Meteorological Satellite* (*SMS*)—currently on NASA drawing boards.

One was whether a spacecraft could achieve and maintain a synchronous orbit. The other involved the feasibility of communications to and from a spacecraft at an altitude of 22,300 miles.

Syncom II answered both in the affirmative.

The active communication satellite was launched from Cape Canaveral at 10:33 a.m. EDT on July 26 by a three-stage *Delta* rocket.

All stages of *Delta* performed according to plan. Within minutes, the 79-lb. satellite was sent into an egg-shaped orbit ranging from 140 miles to nearly 23,000 miles above Earth. At 4:06 p.m. EDT, the satellite's apogee kick motor was fired, putting the spacecraft in a near-synchronous orbit within an apogee 22,823 miles, a perigee of 22,132 miles, and a period of 23 hours and 28 minutes.

Early communications tests of the spacecraft indicated it was functioning perfectly. Music and speech broadcast by the Navy ship Kingsport in the Lagos, Nigeria, harbor was clearly relayed back to the ship's receiving station.

● **Kickback**—Shortly afterward, observation revealed that the spacecraft was drifting eastward instead of westward at the planned rate of 7.5 degrees per day.

On July 27, *Syncom II's* peroxide jets were fired, reversing the satellite's drift from east to west at a rate of 5 degrees per day. This will put the satellite in its desired position of 55 degrees longitude west and moving 30 degrees north and south of the equator at an altitude of 22,300 miles.

On July 31, successful teletype and voice communications were transmitted between the Kingsport and the Fort Dix, N.J. tracking station.

Later that day, at 4:40 p.m. EDT, a signal was sent to the spacecraft which reoriented it to within ten degrees of its planned attitude. Further attitude refinement is planned.

The reorientation turned the spacecraft some 80 degrees so that *Syncom's* antenna pattern will always strike the Earth. At the same time, the peroxide jets were again fired to increase the satellite drift rate to the west to 5½ degrees per day. This should put the satellite on station over Brazil on Aug. 15, rather than the predicted date of Aug. 19.

Extensive communications relay tests of voice, teletype, and facsimile will be conducted between the Kingsport and an Army ground station at Lakehurst, N.J., after the satellite is in position.

Spokesmen for Goddard Space Flight Center, managing agency for *Syncom,* said another spacecraft is available, but they could not estimate when it will be used. They also said they could not tell at this time whether changes or modifications will be made to the spacecraft.

Syncom II was originally scheduled for launch on July 23.

● **Delays**—Three unrelated bits of trouble cropped up during the pad checks of booster and spacecraft. Each contributed a one-day delay.

The first malfunction involved defective hydraulic actuators on the second stage of *Delta,* the second was a false signal from the spacecraft, and the third was defective gyros in the first-stage.

Syncom, designed and built by Hughes Aircraft Company, is a drum-shaped spacecraft 28 in. in diameter and 15½ in. in depth, exclusive of antennas and apogee motor. ■

All-Oxygen Tests Reveal Toxicity

Subject's symptoms attributed to oxygen-rich, nitrogen-poor atmosphere; NASA believes 100% oxygen safe for first Apollo

THE AIR FORCE has reported that all subjects in a series of 17-day exposures to 100% oxygen at 33,500 ft. altitude equivalent had symptoms of oxygen toxicity. NASA presently plans to use 100% oxygen for the 14-day manned lunar landing missions in Project *Apollo*.

While all the toxicity complaints were considered minor, the Air Force Aerospace Aeromedical Div. researchers said that it should be assured "that engineering gains are sufficiently great to offset symptoms noted in the study."

In a paper recently published in a technical journal, the Air Force experimenters note that a few of the conditions could be caused by other test factors. However, they said "We cannot exclude the possibility that the symptoms noted in this study were due to the oxygen-rich, nitrogen-poor atmosphere." They added, "It is also possible that they were related to the increased insensible water loss from the mucous membranes due to the reduced pressure involved."

Effects of 100% Oxygen Exposure for 17 Days***

SYMPTOM	OCCURRENCE (NO. SUBJECTS)
Substernal pain	1
Lower respiratory tract:	
Reduced vital capacity*	8
Upper respiratory tract:	
Cough	4
Nasal congestion	6
Sore throat	1
Ear discomfort (Aural atelectasis)	5
Fatigue	–
Eye irritation	7
Other:	
Paresthesia	4
Dizziness	2
Aching teeth*	1
Joint or muscle pain**	1

Probably related to reduced barometric pressure.

** *Four other cases were noted and were probably related to reduced barometric pressure.*

*** *Reprinted by permission of Journal of Aerospace Medicine, July 1963, p. 590. Morgan, Ulvedal, Cutler and Welch.*

There were no indications of anemia as reported in two-week 100% oxygen studies at Republic Aviation, and all subjects returned to normal in the 7-10 day post-experiment medical evaluation.

The tests were conducted by a group led by Dr. Billy E. Welch, Capt. Thomas E. Morgan, Dr. Frode Ulvedal and Capt. Ralph Cutler of the School of Aerospace Medicine, Brooks AFB, San Antonio, Tex. Follow up studies have been performed on the eight subjects who remained normal.

The following effects were reported in the 17-day exposures to 100% oxygen at ambient cabin pressure of 190 mm Hg:

—All subjects reported symptoms which previously have been attributed to oxygen toxicity.

—Almost all the men complained of nasal congestion or dryness, especially in the first days of the test. About half developed a mild cough.

—Five subjects had ear discomfort and difficulty clearing blocked ears.

—Cold sensations, flushing or tingling of extremities (paresthesia) were noted by 50% of the subjects.

—At least two subjects had an arterial oxygen unsaturation.

—All but one subject had eye irritation.

—One subject had burning substernal (chest) pain on the ninth day, lasting 24 hours.

—All eight had reduced vital capacity of the lungs, averaging 7.6% less than pre-test capacity.

The researchers noted that some of the irritation effects could result from the fact that the subjects breathed dry oxygen in preparation for the test. However, they added that since normal humidity (35-65%) was re-established quickly, this did not seem likely.

The reduced vital capacity, perhaps the most significant finding, probably was due to the effects of reduced pressure. However, this and the reduced oxygen level in the arteries are symptoms of pulmonary atelectasis. The doctors said it is possible that the absence of nitrogen could produce atelectasis by a combination of physical and chemical effects.

- **Bends**—In spite of careful preparation, including two hours breathing 100% oxygen from masks, 50% of the subjects had bends (caused by nitrogen bubbles in the blood). The doctors recommended that the preparation techniques be reappraised. They also indicated that criteria for crew selection should be examined.

The Air Force paper, published by the Aerospace Medical Association, follows a running discussion by space medical experts on the decision of NASA to use a one-gas, 100% atmosphere in the 14-day *Apollo* lunar-landing mission.

- **More tests planned**—Future investigations at SAM will include a 30-day, 100% oxygen exposure at 245 mm Hg (28,000 ft.), and a study of helium-oxygen environment to evaluate the effects of the absense of nitrogen and the effects of other rare gases as diluents. Further long duration exposures of 100% oxygen at reduced pressures are being carried out with animals.

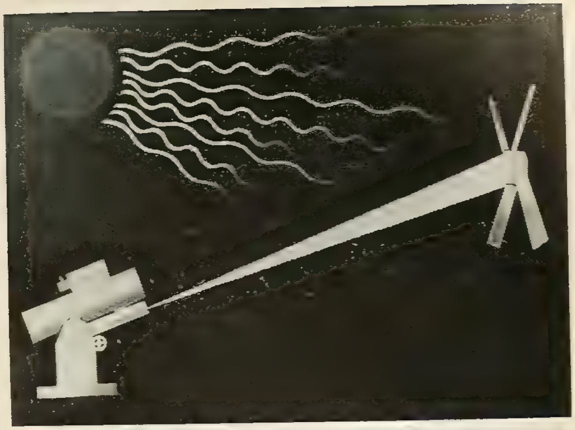
NASA's official position is that 100% oxygen is safe for two weeks, but must be further investigated before it is used for prolonged flights. However, a number of industry and other agency doctors contend that the symptoms which have shown up in short tests are significant enough to warrant serious re-examination of the *Apollo* decision.

The agency has put out a study contract on a two-gas life support system for the longer-mission *Apollo* space laboratory. ■

hances 'marginal' . . .

S-66 May Be First pace Test of Laser

Device at Wallops would track satellite; lobal survey of ionosphere involves more than 40 foreign and U.S. experimenters



ARTIST'S CONCEPTION shows laser (left) mounted on 18-in. telescope optically tracking S-66 in its polar orbit.

THE U.S. WITHIN the next two eeks will attempt the first laser experient in space—using the *S-66 Ionohere Beacon Satellite.*

The experiment will be conducted / means of reflectors attached to the tellite, but because it is a first attempt e space agency said "chances of success are marginal."

S-66 will be launched by a *Scout* ooster from the Pacific Missile Range o earlier than Aug. 15.

In addition to the laser test, the satelte's radio beacon will be used to make global survey of the ionosphere.

• **Laser test**—The experiment will tilize a 10-pound array of 360 one-inch lass-like reflectors designed to send ack to Earth light signals aimed at it rom a laser device.

The laser mounted on an 18-in. telecope will be housed in a 60-ft.-high ower located 20 miles south of NASA's Vallops Station, Va.

It will be used to optically track the atellite during periods when the spaceraft will be illuminated by the Sun and he tracking station is in darkness.

Operators will aim the telescope long the predicted path of the *S-66* and vhen they see it, scientists will "flash" he laser light. If all goes according to lan, the reflector array will be iluminated and will return the light energy to the telescope. The reflected signal will then be automatically amplified by a photomultiplier. An electronic timing device (a digital counter) will record how long it took for the light signal to go and come back. The measurement of time between initiation of the light and reception at the photomultiplier will give the precise position of the satellite.

• **Ionosphere survey**—Because of the simplicity of read-out equipment needed (antenna, radio receiver, timing device, and a recorder) to gain *S-66* information, scientists from all over the world will participate in the ionosphere experiment.

To date, over 40 foreign and U.S. experimenters have volunteered to take part in this program, the largest cooperative group ever to take a direct part in a NASA space satellite experiment.

NASA will attempt to place the satellite into a near circular polar orbit, inclined 80 degrees to the equator, at an altitude of about 600 miles.

In this type of orbit, the Earth will rotate under the satellite, permitting the satellite to view each area of the Earth's ionosphere every 24 hours.

NASA will inform experimenters of the times when the satellite is expected to be within range of their stations. Instruments can then be turned on to record how certain radio emissions from the satellite change as they pass through the ionosphere.

By studying these changes, scientists expect to:

—Relate ionospheric behavior to the solar radiation that produces the ionization—vitally important, as it is solar activity which is believed to disrupt radio communications.

—Learn the bulk behavior of the ionosphere as it varies in time and space.

—Measure the electron content in the ionosphere between the satellite and Earth as related to latitude, season and diurnal time.

—Determine the geometry and distribution of small scale irregularities in the ionosphere.

• **The satellite**—*S-66* is an adaption of the Navy's *Transit* navigational satellite and was designed and built for NASA by the Applied Physics Laboratory of Johns Hopkins University.

The octagonal-shaped satellite weighs about 120 pounds. A bar magnet, one-half-inch wide and ten inches long and located in the spacecraft, will passively orient the satellite along the Earth's magnetic field. This will keep the laser reflectors pointing toward Earth while the satellite is in the northern hemisphere, and provide more stable radio signals for the ionospheric experiments.

Four blades, covered with solar cells to convert the Sun's energy into electricity to recharge nickel cadmium batteries, extend from the sides of the spacecraft. These blades are 66 in. long and 10 in. wide. The power system is adequate to operate the satellite components for about three years.

The spacecraft shell, 18 in. in diameter and 12 in. high, is made of honeycomb nylon and fiberglass. An electron probe extends from the top and bottom of the satellite. Two 5-ft. whip antennas and two dipole antennas for the transmitter extend from the ends of opposite blades. The whip antenna for the satellite's command receiver extends from the bottom of the satellite.

In the launch configuration, the four blades are folded down over the fourth stage of the *Scout* launch vehicle and are held in place by the cables of the de-spin weight assembly. The adapter that mates the *S-66* to the fourth stage rocket contains switches that are timed to release the de-spin cables about seven minutes after motor burnout and injection into orbit.

Twice as many solar cells as needed for initial power have been fixed to the satellite blades. As the cells deteriorate because of radiation effects, reserve banks of solar cells will be commanded into the operation system to provide electrical energy. ■

Nuclear Energy Conversion Projects Create New Opportunities for SENIOR SCIENTISTS: PHYSICISTS, CHEMISTS & NUCLEAR ENGINEERS

Allison—the Energy Conversion Division of General Motors and long-famous leader in production of aircraft engines—is chalking up significant accomplishments in nuclear energy conversion and aerospace programs. High priority projects at Allison have created exceptional opportunities for additional SENIOR SCIENTISTS . . . PHYSICISTS . . . CHEMISTS and NUCLEAR ENGINEERS—with advanced degrees and related experience. MCR (Military Compact Reactor) under development by Allison for the Atomic Energy Commission, is designed to meet the urgent requirements of army field forces for a completely mobile nuclear power source. MCR will have a high temperature, liquid metal-cooled reactor coupled to a power conversion system capable of generating 3000 kw of electricity. Also under contract at Allison is the development of a Nuclear Powered Energy Depot which could eliminate cumbersome and vulnerable fuel supply lines by powering military vehicles through nuclear power. In one Energy Depot concept, the reactor system would provide power for synthesizing a fuel from universally available elements, such as air and water. Or, electricity produced by a mobile reactor could be used to charge a combined cell powerplant which would supply electric power for vehicle propulsion. Further development for lunar and satellite applications is also under study. Additional Allison contracts include propellant components for APOLLO; pressure tanks in the TITAN III thrust vectoring system, and rocket motor cases for MINUTEMAN. Acceleration of these—and other—solid programs means exceptional and challenging opportunity for those who can qualify.

We need PHYSICISTS, CHEMISTS and ENGINEERS, some to head groups, in the following areas:

Scientists and Engineers	For NUCLEAR SYSTEMS ENGINEERING • NUCLEAR REACTOR DESIGN
Physicists and Engineers	In field of advanced propulsion and power systems. Specific areas are: NUCLEAR SYSTEMS ANALYSIS • SYSTEMS APPLICATIONS • COMPONENT ANALYSIS

We also have key research positions open in the following disciplines:

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Plasma Physics	Physical Chemistry	Electro Chemistry

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Technical Countdown

ELECTRONICS

New Sprint Contract Revealed

Autopilot inertial components for use in the *Sprint* low-altitude anti-ICBM will be developed and manufactured by Minneapolis-Honeywell. Awarded by Martin-Orlando, *Sprint* prime contractor, the contract reportedly calls for early delivery of the units, which will then be employed in the Western Electric autopilot. The latter will provide a stable reference and actuate control signals for the vehicle during powered flight. The autopilot is a part of the Bell Telephone Laboratories' radio command guidance system now being developed for *Sprint*.

Nuclear Thermionic Reactor Funded

General Electric scientists are conducting a six-month design analysis of the STAR-R (Space Thermionic Auxiliary Reactor) under funding from the Air Force Weapons Laboratory. The generator design may be capable of producing 100 kilowatts of power with a specific weight of 15 lbs./kw. The device consists of a small nuclear reactor and a system of thermionic converters. Design goals call for continuous operation for more than 800 days. The concept is the result of a research project of the GE Special Purposes Nuclear Systems Operation in Palo Alto, Calif., and the Weapons Lab's Nuclear Branch.

Super Accuracy Claimed for Syncom Tracker

Based on antenna design only, Sylvania Electronic Systems Division of General Telephone & Electronics Corp. claims its 60-ft. dish at Fort Dix is capable of tracking *Syncom II* to an accuracy of 0.024 degree. The antenna system, riding on a 60-ton AZ-EL pedestal, has a slewing rate of 60 degrees/sec.

Pegboard Mounting Slated for Saturn

For electronics cooling in *Saturn* rocket instrumentation, a water-methanol coolant will be circulated through a mounting-panel honeycomb maze. The 30 x 30-in. panels, to be built by Fairchild Stratos for NASA under a recently announced $78,000 contract, will each be provided with a matrix of holes in a standardized pattern for flexibility in mounting instruments.

PROPULSION

Big Solids Insulation Materials Tested

Using a low-cost, reusable "char" motor, researchers at Lockheed Propulsion exposed 15 heat-resistant materials to a 37-second solid firing. The test had three major objectives. The comparative evaluation of seven proposed jet tab materials, eight insulation materials and heat flux environment studies of the jet tabs. LPC is designing and building two segmented 156-in. diameter solids under the Air Force's large solids program. Both will use jet tab systems for thrust vector control.

ADVANCED MATERIALS

Liquid Metal/Refractory Interface Studied

Atomics International Division of North American Aviation, Inc., will investigate the interactions of liquid alkali metals with refractory metals in heat transfer systems aimed at space electrical power generation. The $400,000 contract from NASA's Lewis Research Center will have as its prime purpose the acquisition of data leading to the development of more corrosive-resistant high temperature alloys.

Radiation Hygrometer Under Development

Air Force scientists at the Cambridge Research Labs are testing a new hygrometer based on detecting the absorption of alpha radiation by a frost or dew deposit. The unit is far more sensitive, accurate and precise than conventional hygrometers and reacts much faster. The hygrometer consists of an alpha radiation source, a thermoelectric cooler, radiation counters and a thermisistor. Condensation and evaporation on a mirrored surface form the basic measurement. The precise knowledge of atmospheric water vapor is necessary to the development of infrared sensing devices.

High Rate Chamber Pump Available

A Penning vacuum pump, capable of an evacuation rate of approximately 100 liters/sec. over the range of 5 x 10^{-3} to 10^{-10} torr, has been developed by Mullard Equipment Ltd. Working from an input of 5,000 volts, instead of the normal 3,000 volts, pumping rates can be steadily increased, the British firm claims (max. rate, however, was not disclosed).

Thermo-Lag Use Increases on Saturn

Emerson Electric's thermostatic temperature control material will be used in the interstages, fins and aftstructure of the *Saturn I-B* series. The materials, trademarked "Thermo-Lag," control temperature penetration by sublimation, taking advantage of the constant temperature characteristic of the phenomenon. Thermo-Lag compounds can be tailored to specific temperatures and the materials have been used on the *Saturn I* vehicles.

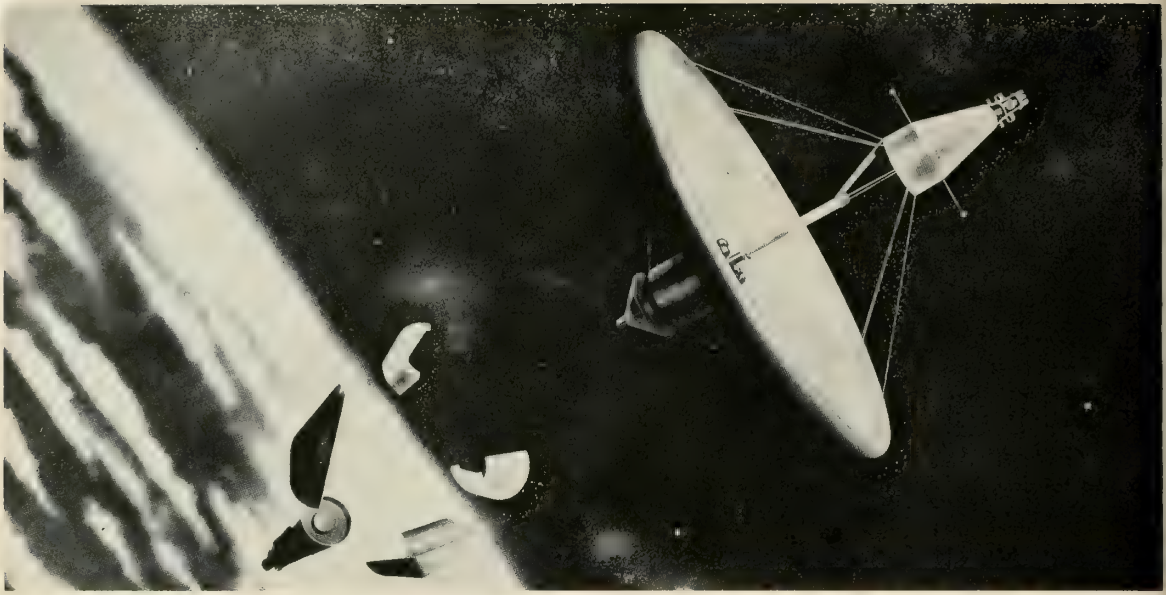
Crystals Grown on Glass Substrates

Scientists at Martin-Orlando have reported progress in growing single-crystal silicon films on glass, quartz and other "amorphous" substrates as well as on metallic compounds. The work is aimed at producing thin-film elements for use in electronic devices and harmonic frequency generation.

SPACE MEDICINE

NASA Life-Support Test Interrupted

A NASA-sponsored test of a five-man, closed life-support system at the Boeing Co. has temporarily been halted for adjustments to the activated sludge water recycling system. Thus far, the sodium superoxide oxygen regeneration system has worked satisfactorily. The test will resume in about a month, and is scheduled for 30-day duration.



ARTIST'S CONCEPTION of Boelkow satellite.

German Satellite Contract Due Soon

Commercial payoff goal dominates R&D; NASA balks at sophistication; contract odds favor Boelkow-Entwicklungen

by William Beller

MUNICH—The German government is expected to award a contract for this nation's first satellite within the next month or so.

Detailed design of the structure and components for such a spacecraft, possibly weighing 3,300 lbs., has already started at Boelkow-Entwicklungen K.G. of Ottobrunn, outside of Munich. Other firms are working on proposals, but Boelkow is rated the favorite.

Proposed experiments for the Boelkow satellite, expected to be launched in 1967, are being submitted by the Geophysical Institute of the University of Cologne, and the German Institute for Aviation and Space, also in Cologne.

The project, as envisioned by Boelkow, will involve 39 tasks, two-thirds of them performed by firms other than the prime contractor.

Preliminary design of the Boelkow satellite assumes a launching by an *Atlas-Agena*. It is hoped that NASA will furnish the vehicle. If the space agency refuses, which it probably will do unless there is a sharp change in policy, the Germans may seek to buy the launcher.

This decision, though, would also require some U.S. policy changes. So far, only *Thors* and *Scouts* have been available for foreign use. "The *Atlas* has never been considered," says Arnold Frutkin, NASA's director of international programs.

"If the *Atlas-Agena* is not available, we may have to wait for the European Launcher Development Organization (ELDO) rocket with a high-energy third stage," said Gerhard Barthel, Boelkow's project engineer on satellites. "This means we would have to hold off on our satellite design because such a stage would not be ready in time."

• **A commercial venture**—German technologists are eager to use such a satellite for economic purposes—such as communications, weather surveillance and navigation—rather than for purely scientific tasks with little commercial payoff.

This fact is not baldly stated by German industry because such an approach would engender opposition in the country's universities. It is, nonetheless, clearly reflected in an almost non-existent national budget for basic research, in the imminence of the German government contract to develop a satellite, and in a space budget largely devoted to technology projects such as space transportation vehicles, high-energy propulsion systems and large simulation chambers.

The strong desire of German industry to skip the freshman courses in space technology and enter advanced studies was also apparent at a recent "closed door" discussion a dozen German industrialists held with Frutkin in Stuttgart.

• **Walk before you run**—At the meeting, Frutkin tried to persuade the representatives to begin their space work with simple scientific experiments placed aboard NASA satellites. He pointed out that this was the route Great Britain, Canada and Italy were taking "quite successfully."

Then larger experiments can be undertaken, he said, and NASA may cooperate in launching an all-German satellite—just as the space agency helped launch the *Alouette* satellite for

Canada, and is cooperating with Italy on the San Marco project (a plan calling for a satellite launched into an equatorial orbit from a floating site on the Indian Ocean.)

● **Prefers to run first**—The suggestion was coolly received. Ludwig Boelkow, president of Boelkow-Entwicklungen K.G., put on the conference table a 5-lb. report covering the preliminary design made by his firm of the proposed 3,300-lb. satellite. "Can we ask for NASA cooperation on this project?" he said.

Frutkin stated the U.S. space agency's position:

—NASA will cooperate with other countries only on space projects that can be of mutual benefit. These projects have so far been solely scientific ones and there is no reason to believe the situation will change in the near future.

—NASA's cooperation does not include any transfer of funds, but instead a sharing of facilities, services and manpower. (Some U.S. industrialists have complained to MISSILES AND ROCKETS that when NASA shares its facilities, it's the same as giving away a potential market for American equipment.)

—NASA will certainly evaluate the Boelkow satellite—if it becomes a proposal of the German government—but chances are the space agency will find nothing in the proposal that will aid the U.S. space program.

Frutkin described the Boelkow satellite as a "streetcar" that could carry many experiments. The U.S. has no objection to the idea, but is itself actively taking the same tack with its "observatory" satellites.

Even if NASA decided to go along with supporting a German "streetcar," Congress, for economic reasons, probably would kill the program just as the House Space Committee late last month cut NASA's proposed budget for $4 million for "follow-on international satellites."

● **Maybe without NASA**—At the Boelkow plant near Munich, shortly after the Stuttgart meeting, an official of the company told M/R that even without NASA's help, Germany would want to launch a satellite. This opinion was stated by several other German industrialists as well as by an aide to Hans Lenz, newly appointed German Federal Minister for scientific research.

Germany would much prefer, however, to work with NASA and get the benefit of its experience and facilities. Lenz visited NASA last month to explore the possibility of space cooperation. The conversations were general and no specific projects were discussed. A follow-up meeting is scheduled, and specific projects will presumably be considered.

● **Industry advises Ministry**—In Germany, industry has a strong voice in what kinds of R&D contracts are awarded by its government and to whom (M/R, July 22, p. 22).

The program Boelkow is recommending to the German Ministry calls for developing five satellites, the later ones having the ability to change orbits.

R&D and construction costs for the satellites is expected to run between 150- and 300-million deutschemarks (four per dollar), without considering charges for launch vehicles, according to the company estimate.

The first satellite is to have an elliptic orbit with a perigee of 248 miles (400 km) and an apogee of 930 miles (1,500 km). The orbital axis will be inclined 15° to the Earth's axis of rotation, making the orbit a near-polar one. Details of the orbits of the follow-on satellites have not been disclosed.

The satellite is to comprise three main parts: a mercury turbine-generator set able to supply 5-kwe power; an inflatable solar mirror to direct heat to the powerplant; and a payload and housekeeping capsule.

When the satellite is in the Earth's shadow, energy for the powerplant will be extracted from the heat of fusion of a bank of lithium hydride.

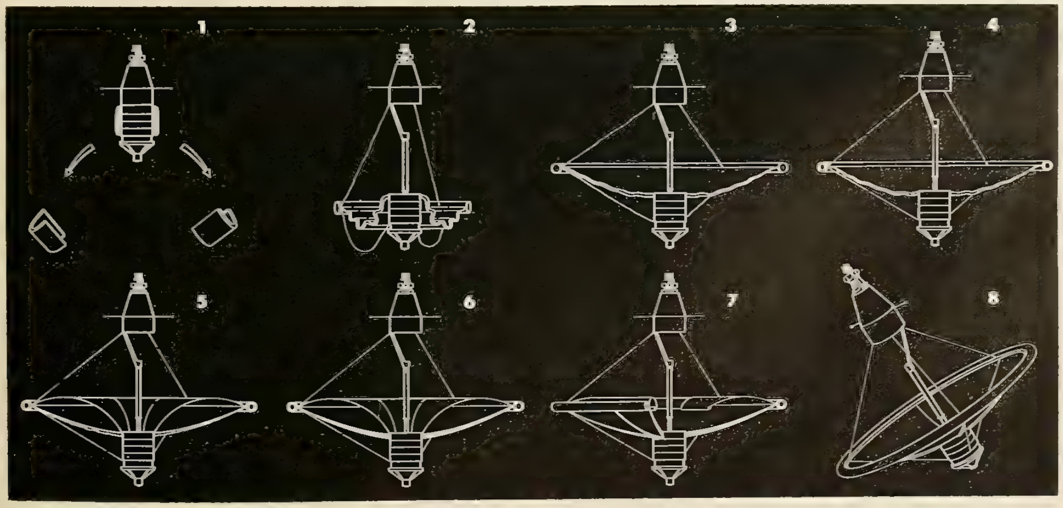
Within the payload and housekeeping capsule, modules are stacked like chips, making it easy to change one module for another and bringing out the "streetcar" character of the satellite.

In the first satellite, the terminus of the capsule is a re-entry body, designed to carry instruments back to Earth as well as to study the re-entry phenomenon itself.

Structural weight of the entire satellite will be about 2,200 lbs. (1,000 kg), with the remainder of the weight going into instruments and re-entry body.

The satellite is to get stabilizing signals from a solar sensor plus two star sensors. Stabilizing pulses will come from eight ion engines, four outrigged from the body of the mercury powerplant, and four mounted on its apex. Thrust of each powerplant will be 0.1 grams.

Satellite life is expected to be about five years. Within this time, the German space industry expects to tutor itself sufficiently in space technology to pick some of the commercial plums. ■



SEQUENCE IN deploying satellite: (1) Shrouds cast off. (2) Tele-cope mechanism separates subsystems. (3) Gas inflates supporting orus of 10-meter-dia. solar mirror. (4) Plastic in torus forms a foam with the gas. (5) Compressed air admitted between solar mirror and a foil. (6) Plastic foam solidifies shape of newly formed mirror. (7) Foil electrically destroyed. (8) Satellite ready for use.

New Spacecraft Window Design Proposed for Apollo

Arthur D. Little says use of compound reflective system could solve some window and shielding problems in space and re-entry

by Michael Getler

A NEW CONCEPT for spacecraft "windows," which would afford *Apollo* astronauts a maximum 141-degree outside view through an aperture of less than one inch diameter, has been proposed by scientists at Arthur D. Little, Inc., Cambridge, Mass.

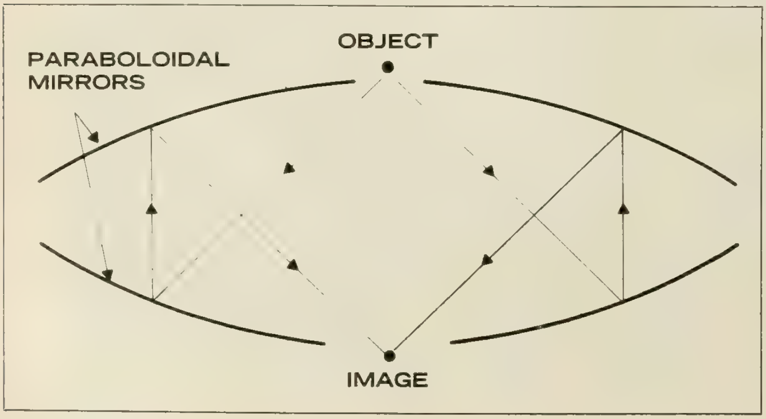
The system, embodying fairly complex optical principles in relatively simple hardware, could remove certain design constraints imposed by the effects of atmosphere re-entry heat and prolonged exposure to the lunar environment on larger conventional-type windows.

The ADL system uses a compound reflective optical scheme in which two paraboloidal mirrors are mounted with reflecting surfaces facing each other so that the focal point of each coincides with the vertex of the other. Small holes, about 1-in. in diameter, made at the mirror vertices allow the cone of radiation from external objects to enter the system and that from the formed image to leave.

By placing one eye at the inner paraboloid viewing hole, or with suitable optics, ADL scientist Peter E. Glaser reports that "the system offers a completely distortion-free view over a maximum 141-degree angle with an excellent sense of depth and perspective."

The small circular view directly along the optical line-of-sight (LOS) through the two vertices is a true "right-side-up" view. The total reflected image is inverted. This feature, though it takes on certain "blindspot" characteristics in respect to the overall view presented, is felt to have certain tracking and orientation advantages.

With a movable system, ADL reports, an image can be maneuvered to the center of the system, where it will disappear from the reflected scene and simultaneously re-appear (right-side-up) in direct view, providing quick directional read-out. Also, they note the direct view can be offset so that it does not appear to be straight ahead.



DRAWING shows theoretical reflection path for object directly along optical line of sight. Actually, view directly through mirror openings is of real object.

• **Fewer holes in shielding**—Using windows of the type, Glaser stresses, would expose a minimum area to the space environment (just the 1-in.-dia. opening of the outer paraboloid), without diminishing visual capabilities.

Glaser emphasizes that there are many advantages in use of larger, more conventional "picture" windows for spacecraft if they can be effectively included in design, but adds that the compound reflective system ADL proposes offers an alternative if it is not possible to use other devices.

A major advantage of the ADL approach, he reports, is that it would necessitate less compromise on heat shielding than would the larger windows. ADL says it would also obviate the need for extensive window protection schemes and thermal control devices, such as shutters or other mechanical systems. Structural integrity losses associated with large window areas would be minimized.

Depending on the degree of aerodynamic heating expected, two types of window arrangements could be used.

If heating is not severe enough to melt, distort, or overly stress window materials, ADL says quartz, sapphire, and magnesium oxide coverings could be used for the outer paraboloid opening, which would be flush with the vehicle skin. This can be installed without maintaining a vacuum seal, they say, but the window support must be designed to provide for thermal expansion.

A second window, installed in the inner paraboloid facing the vehicle interior, will not be subject to aerodynamic heating, and a metal-to-glass vacuum seal can be made more easily with this "cooler" window.

The inside window would heat by radiation, but this can be reduced, Glaser points out, by filtering between

ARTIST'S CONCEPTION of lunar landing view using ADL mirror system with second optical system to invert landscape image to appear right-side-up. Rim of crater in small view at center is actually direct view through two mirrors. Center view appears proportionately larger than imaged objects, and is inverted by system making rest of scene right-side-up.

the mirror vertices and using a gas coolant to remove absorbed heat.

- **Aerodynamic window**—If severe heating is expected, an aerodynamic window arrangement could be installed that would remove the need for any external covering.

In this configuration, the small opening in the skin forms a cavity in much the same manner as that formed by a pressure tap mounted in a surface parallel to an air flow.

A bell jar arrangement is then installed inside the cavity, forming the cavity boundary but not interfering with the optical system. This, in effect, protects the mirrors by cutting off turbulent high-temperature air flow. Glaser says that some cooling of the jar will probably be needed, but he doesn't expect the demands to be severe since the air in the cavity, though at high temperature, will be nearly stagnant.

Creating a vacuum within the reflective system in this configuration will allow pressure control and reduce possible bell jar heating deformations. Infrared filtering could also be used either within the mirror system or in any associated optical system.

The system, says Glaser, can be formed so that the hardware is an integral part of the vehicle structure, with the inner spacecraft shell providing support for the outer mirror. A vacuum weld would be made along the edges of the mirror hole.

Use of a metal or plastic honeycomb backing for the highly polished aluminum mirrors would prevent mirror shape distortion under adverse temperature or pressure conditions.

The geometry of the compound reflective system that yields the maximum 141-degree view angle is such that the aperture ratio (diameter of the mirror rim divided by focal length) is 2.83. Smaller angles can be obtained with smaller apertures.

(Continued on page 43)

AMF Study Cites Solids Handling Needs

AFSC-funded investigation shows ground equipment exists for 120-in. rocket motors, 156-in. solid segments strain existing capability, 260-in. tools nonexistent

NEW YORK—A new and comprehensive survey of aerospace ground equipment (AGE) requirements for large solid-propellant rocket motors states that equipment for handling 120-in. diameter segments is generally available, equipment for handling 156-in. segments approaches the upper capacity limit of available lifting and transporting devices, and no applicable equipment is on hand to deal with a 260-in. monolithic motor.

The study (M/R, Dec. 24, p. 20), conducted by American Machine & Foundry Co.'s General Engineering Div. with major propulsion input from United Technology Corp., was funded by the rocket propulsion laboratory of the Air Force Systems Command at Edwards AFB, Calif.

An evaluation of AGE cost vs. launch rates was made, AMF reports, for the 120-in. and 156-in. segments. Included was AGE at the manufacturer's plant, static test site, and launch site. AGE costs for the 156-in. segment were found to be about three times as high as for the 120-in.

Military handling and transportation equipment, the report shows, generally is not heavy enough to handle loads imposed by either the 120-in. or 156-in. solids. Some shipyard cranes can currently handle these, but availability is uncertain.

The report notes that where the basic design of existing equipment is not affected, certain minor equipment modifications and additions could be made to expand usage for some AGE tasks. However, the report warned that major modifications to load-carrying devices, which are generally rated for the maximum manufacturer-guaranteed load, are tantamount to redesign.

"Any significant increase of this carrying capacity will result in an engineering program to determine new configurations." AMF says that companies contacted with requests for major modification information responded by saying they would require funded study programs to get the answers.

- **Advances coming**—The report also notes that lifting devices with capacities up to 32 million lbs., using hydraulics or electrically driven screw jacks, are currently within the state of the art. Gantry cranes are being designed for capacities of 5,000 tons. Crawler-mounted transporters with capacities to 5 million lbs. are being built.

AMF lists the following limitations for various transportation methods: long distance highway travel—generally limits dia. to 13 ft. and weights to 100,000 lbs., though some road modifications may be made; rail—dia. to 13.7 ft, weights to 500,000 lbs.; air—dia. to 10 ft, weights to 100,000 lbs; water—limited only by off-loading facilities and the transporting vessel.

Cost savings in AGE design can be realized by standarding program equipment so that identical gear can be used at all test sites (both industry and user) in a particular project. Where programs encompass more than one motor size, it is highly desirable to design equipment that can handle all sizes, and also attempt to make multipurpose equipment compatible with handling liquid fuel and nuclear stages.

AMF says additional effort is needed in two cost areas: a study of special equipment costs vs. universal equipment; and more details on development of modular equipment concepts, where smaller, off-the-shelf type modules can be used for building a variety of complex handling and transport devices. This latter approach appears to offer promise for substantial savings.

The report also calls for greater attention to be paid to new solid-propellant motor inspection methods, cutting down on current relatively time-consuming radiographic, ultrasonic, and visual methods.

Continuous inspection techniques are needed. As an example AMF cites work being done by Applied Radiation Corp. and Varian Associates in fluoroscoping methods to replace X-ray techniques. Also mentioned are efforts by the Perkin-Elmer Corp. to develop infrared inspection methods to detect laminar bonding defects.

- **Exhaust problems**—Another AGE area that needs more R&D, according to the report, is protection of equipment from effects of solid-propellant ehaust from large motors. Conventional flame deflectors will erode quickly, and moving them farther away does not seem to be the answer in view of facility costs.

The problem is apt to get even more severe, AMF claims, with the advent of large multimotor solid boosters where a period of pad "hold down" is required.

The report cites a study made by Hughes Aircraft Co. of this problem recommending that a series of tile-like sections of phenolic fiberglass compression mold material could be easily put together on a steel frame to form an economical, transportable, and easily replaceable deflector.

Hughes was also cited in the report as having recently developed a proprietary method (called the "Keller" process) for high-pressure molding of solid-motor sections of almost unlimited size.

Several studies are being conducted aimed at handling a 260-in.-dia. monolithic motor. The capability for on-site fabrication of the motor cases, closures, and nozzles would be a distinct advancement in the state of the art, according to the report.

The report concludes that a completely above ground facility for manufacturing/static tests was superior to either submerged or semisubmerged facilities on the basis of greater reliability, finer control during handling and erection, and lower overall facility cost.

(Copies of the AMF report can be obtained from the Armed Services Technical Information Agency (ASTIA), Arlington, Va. ■

One Ion Rocket Could Hold Satellite Synchronous

REPLACEMENT OF three-axis thrustor systems by a single radial thrustor can greatly simplify stabilization of stationary synchronous satellites, says R. S. H. Toms of Electro-Optical Systems, Inc. He suggests stabilizing the 550-lb. *Advanced Synchronous Satellite* by a single ion rocket—firing continuously in a radial direction.

The present proposal for the satellite calls for three mutually perpendicular groups of three thrustors, firing intermittently.

Simplification of installation and control—by using only one thrustor and turning it on once instead of a possible 50,000 times—suggests a considerable gain in reliability. For a three-year satellite this is highly desirable. However, operational experience in ion rocket reliability has yet to be obtained.

Another unknown is the effect on the satellite's communication channels of the ion exhaust. This is expected to form an ionized plasma column extending a very great distance into space. It may or may not be a source of radio interference. Very little is known about a plasma column of this sort. It might even prove suitable as an antenna—making a metallic antenna superfluous.

● **EOS Approach**—Toms' proposal for synchronous satellite stabilization rests on two ideas: one, a single radial thrustor can adjust the orbital period, eccentricity, longitude, latitude, and attitude of a satellite; two, an ion rocket, of a design proposed by EOS, is best suited for this application.

As envisaged, the satellite would have a single 2.5-millipound thrustor acting toward the center of the Earth. There would be a means of deflecting the exhaust through angles up to 5 degrees and also of rotating the exhaust at a fixed deflection angle—the latter providing a yaw torque to the satellite.

Static deflection of the ion exhaust would be used to adjust satellite attiude. In turn, an undeflected ion thrust acting through the center of mass of he tilted satellite would provide thrust components tangential to the satellite's orbit and normal to its orbital plane. Satellite tilts of about 1 or 2 degrees would be needed, calling for a sensitive and accurate angular sensor.

If there were no perturbations of orbit or attitude, the satellite would have no tilt and the thrust vector would be aligned along a radius through the center of the earth. Thrust magnitude would be set to hold the period of the satellite to precisely 24 hours.

Apart from errors in the initial orbit, the chief deviations from the desired orbit will arise from Sun-Moon perturbations, and from the effect of non-sphericity of the Earth. The most severe Sun-Moon perturbation causes the orbital plane of the satellite to oscillate with growing amplitude about the equatorial plane. That is, divergent oscillations in latitude occur. The main effect of the Earth's non-sphericity is a change in the orbital energy of the satellite. This causes a continuous change in satellite period and longitude.

● **Period adjustment**—To correct orbital period, the thrustor would be vectored to east or west (by change of satellite attitude). If it is vectored 1 degree east of its radial position, a force of 0.08 micro-g will be developed. This increases the orbital period by 11.4 sec. per day. Maintaining thrust for periods that are multiples of one day ensures that eccentricity is not disturbed.

Errors in longitude must be corrected by a change in orbital period, stated Toms. If the radial thrustor is deflected 1 degree to the east for one day, a westward drift of about 19 miles per day will be set up. With a circular orbit, this drift can continue until the desired longitude is reached. Application of 1 degree of thrust vectoring to the west for a full day will bring back the orbital period to its correct value. Continuous growth of longitude error, due to the Earth's non-sphericity, could be countered by continuously vectoring the thrust by 0.19° to the west. This is the angle calculated for a satellite at 90° West.

Oscillations of satellite longitude would mean an eccentric orbit. When the orbital period is correct, eccentricity can be corrected by vectoring the thrustor first to the east and then to the west, for 12 hours at a time, starting when the satellite is farthest west. At a thrust angle of 1 degree, eccentricity can be reduced by 0.000028 per day. By working in multiples of one day, orbital period will be preserved.

Oscillations in latitude with both diurnal and annual periods can be expected, resulting from Sun-Moon perturbations. Correction of the tilt of the orbital plane must be carried out by developing a north or south thrust vector. A thrust angle of 2.6° North is required during the 12 hours that the satellite is heading north-south—followed by an equal angle in the opposite direction during the next 12 hours, when the satellite is heading south-north. This, said Toms, is the thrust angle required for latitude oscillations that build up at 0.8525° per year.

● **Engine studied**—The thrustor suggested by Toms for this application is the EOS contact and bombardment ion engine. This has an ion-acceleration electrode in the form of a perforated plate.

Detailed experiments on beam vectoring have not yet been carried out, but there is evidence that beam deflection can be achieved by lateral movement of the perforated electrode. Rotation of the electrode should produce the helical beam motion required.

Toms compares a hypothetical single ion rocket having the characteristics required for stabilization of the 550-lb. satellite with a nine-thrustor ion-rocket system. He estimates that their weights will be very similar: 192 lbs. and 189 lbs. respectively. The main weight penalties incurred by the single thrustor are its requirement for 8 times as much propellant and a similar increase in solar cell area, due to its three years of continuous running. In compensation, the nine-thrustor system has a much greater engine weight and requires batteries. ■

PROJECT: F-111 and other Aerospace Programs

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Survey Sees No Cut in M/S Spending

July 29's Value Line Investment Survey, published in New York by Arnold Bernhard & Co., predicts that the recent nuclear test ban agreement will not result in an immediate major reduction in "the mainstream of aerospace spending." The survey sees instead the following military and space contract changes: Contracts will: (1) be larger; (2) represent fewer units; and (3) involve more sophisticated components.

Mergers and Acquisitions

Beckman Instruments, Inc., Fullerton, Calif., has completed acquisition of Sharp Laboratories, Inc., La Jolla, Calif., manufacturer of high-sensitivity radiation measuring instruments and carbon dating laboratories. . . . *International Telephone and Telegraph Corp. is acquiring Cannon Electrical Co., Los Angeles. Cannon will continue design and manufacturing of electrical connectors as an autonomous unit of ITT.* . . . Instrument Corp. of Florida has acquired the optical research and development firm of Worlds Unlimited, Farmington, Conn., manufacturer of space navigation and tracking instruments. . . . *VSI Corp., Pasadena, Calif., has purchased Wintronics, Inc., Hawthorn, Calif., manufacturer of reed relays and related products. The acquisition is to be operated as the Wintronics Div. of VSI's Michigan Magnetics, Inc., Vermontville, Mich.* . . . Straza Industries, El Cajon, Calif., has acquired three Costa Mesa, Calif., missile/space companies, Lido Manufacturing Co., Lido Transducer Co. and Lido Tools Co.

Industry Facilities

The Scionics Corp., Canoga Park, Calif., has added a 27,000-sq.-ft. facility to house corporate offices and its Instrumentation and Information Systems divisions, along with shop and assembly areas. . . . *Howard Research Corp., Arlington, Va., Government systems engineering and program management consultants, has contracted for the building of a 40,000-sq.-ft. office in McLean, Va.* . . . The Vitro Laboratories Div. of Vitro Corp. of America, New York City, has opened a new West Coast office in Palo Alto, Calif. . . . *Space Ordnance Systems, Inc., El Segundo, Calif., has expanded to a new 14,000-sq.-ft. building to accommodate specialized equipment for production, assembly and test missile/space explosive ordnance.* . . . Halex, Inc., El Segundo, Calif., producer of thin-film microcircuitry, has expanded production capabilities with a new 10,000-sq.-ft. plant facility. . . . *Great Lakes Carbon Corp.'s Graphite Products Div., Niagara Falls, N.Y., has begun work on a new research and development facility.* . . . Swedlow Inc., Los Angeles aerospace plastics manufacturer has broken ground for a new plant facility in Garden Grove, Calif. More facilities are to follow on the firm's 22-acre site. . . . *C. P. Clare & Co., Chicago manufacturer of relays and related control components, has established a regional design engineering service in Los Angeles.* . . . The University of Michigan's Institute of Science and Technology plans to build and operate a $5-million astronomical observatory atop 10,000-ft. Mt. Haleakala in Hawaii to study ballistic missile flights and orbiting satellites. The facility is also to provide astronomers with a new range of research tools to explore the heavens. . . . *The American Institute of Aeronautics and Astronautics has chosen the recently completed Sperry Rand Building in New York City to house its headquarters.*

International

Texas Instruments, Inc., Dallas, plans to establish a manufacturing facility at Richmond Hills, Ontario, near Toronto. The plant is to begin producing electrical and thermostatic controls before the end of the year. . . . *Motorola Semiconductor Products, Inc., Phoenix, Ariz., has opened its first international sales office at New Bond Street House, 1-5 New Bond Street, London.* . . . An affiliate of International Telephone and Telegraph Corp., Standard Telecommunications Laboratories of England, has announced plans to build a new 14,000-sq.-ft. addition to its multi-million-dollar plant in Harlow, England. . . . *Northrop Corp., Beverly Hills, Calif., has selected Modern Marketing, Inc., Los Angles, to establish world-wide distributorships for the Northrop Nortronics line of audio-visual products.*

Company Representatives

The Ray Johnston Co., Inc., Seattle, and Howell Sales, Inc., Grand Prairie, Tex., have been named sales representatives for Dorne and Margolin, Inc., Westbury, N.Y. The Johnston Co. will handle D&M's line of antenna and other microwave devices throughout Washington, Oregon and western Idaho. Howell Sales will serve Oklahoma and Texas, with the exception of El Paso County in Texas. . . . *Capitol Pipe and Steel Products, Inc., Philadelphia, has opened branch service offices in New York City and Chicago. CP&SP make pipe, fittings, forgings, flanges and tubing for cryogenic and other chemical applications.* . . . Electronic Material Sales Co., Dayton, Ohio, has been named Michigan-Ohio-Kentucky representative for Microlectron, Inc., Santa Monica, Calif., manufacturer of thin films, integrated circuits and current limiters. . . . *The Florida Service Div. of American Cryogenics, Inc., San Francisco, has opened a new store in the Cape Canaveral-Cocoa, Fla., area. Store is to be located on U.S. Route 1.*

GE Develops Single-Reversal TWT

A NEW SERIES of single reversal permanent-magnet travelling wave tubes with low noise and the capability of close spacing has been developed by General Electric Co.

Functioning as rugged low-noise preamplifiers, the tubes have applications in telemetry systems, advanced radars, and countermeasure systems.

This is believed to be the first single-reversal system commercially available, according to GE. The result is a combination of the physical advantages of a periodic permanent-magnet tube with the low electrical noise of a uniform-field tube.

The new series provides power outputs up to 5 mw and small-signal gains of up to 30 db. With connectors and housings, a tube weighs 8.6 lbs.—half the weight of uniform-field tubes. At X-band frequencies, the noise figures for the new series lie between 6.5 and 9 db, or about 2 to 5 db less than the figure for a periodic permanent-magnet type.

Like the periodic type, the single-reversal TWT needs only very light shielding.

● **Performance detailed**—A figure of 2,000 hours mean time between failures is forecast for the new tubes for normal continuous operation. Current tests applied to the tubes include 50-g loading for 11 milliseconds, and vibration loading from 5 to 2,000 cps. Maximum operating altitude is 100,000 ft. Operating temperature range extends over ±65° C.

Initially, GE Travelling Wave Tube Product Section, Palo Alto, Calif., is putting out five X-band tubes in this series. Further X-band and C-band versions are under development. Metal-ceramic construction is used in all types. Prices vary from $2,700 to $3,000.

Later, the single-reversal focusing principle is likely to be applied to millimeter-wave tubes — for frequencies from 12 to 40 gc.

In the single-reversal TWT, the magnetic field along the axis of the tube is reversed at the center of the tube. To achieve this, the main magnetic focusing structure is made up of two hollow cylindrical magnets of high coercive force. These surround the tube and are separated by a high-permeability steel pole piece, fitted with an internal coaxial "aiding magnet." By this means a sharp field reversal is obtained at the center of the tube's length.

Reversing the beam in this way reduces the de-focusing effect of external magnetic fields or nearby magnetic materials. Previously, tubes have been produced in which the magnetic field is reversed a large number of times (periodic permanent magnet TWT). These are insensitive to external fields, but the periodic magnet structure introduces a certain amount of additional noise into the output of the tube.

● **Single reversal compromise**—Use of a single reversal represents a compromise that provides an improved noise/weight performance. In many cases, the single-reversal tube will replace the uniform-field tube. However, where low noise is less important than very light weight, the periodic permanent magnet tube will be retained.

A typical member of the range, Type ZM-3178 has an operating frequency range of 7 to 11 gc and is supplied as a completely packaged assembly. Including connectors, it is 13 in. long and has a diameter of 4 in. The nominal noise figure of this unit is 8 db; the maximum being 9 db. Small-signal gain is 25 db, and saturation power output is 5 mw. The voltage standing wave ratio, input and output, is 2.5:1.

The other units being marketed are Types ZM-3203 through 6. These have various frequency ranges within the range quoted for the ZM-3178. Type ZM-3205, for example, has a range from 7.5 to 8.5 gc. It has a maximum noise figure of 6.5 db and a minimum small-signal gain of 30 db.

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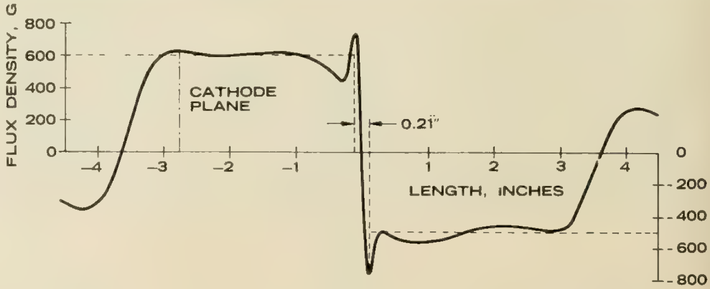
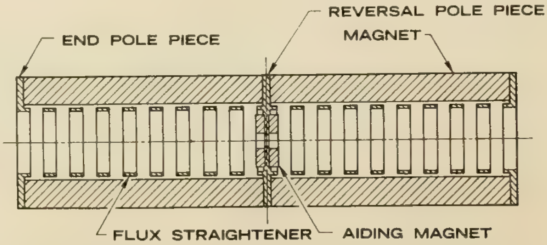
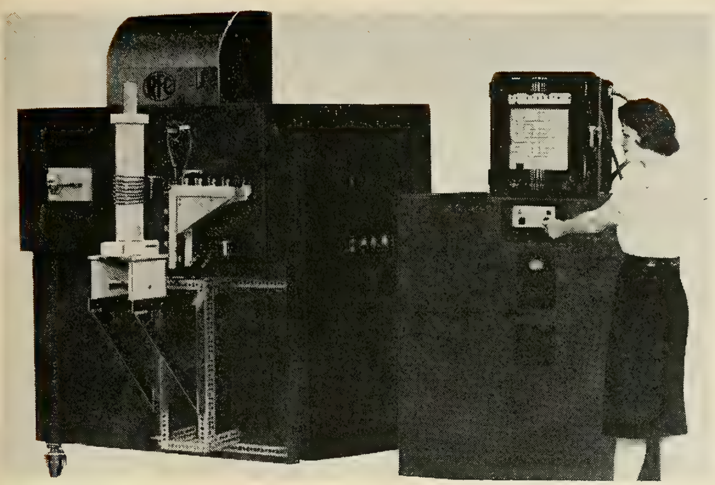


PLOT of magnetic field along the beam axis for a single removal field TWT.



SCHEMATIC OF a single-reversal field PM circuit.



New Product of the Week: RF Laser Rod Annealer

RFC, Inc. is manufacturing a laser rod annealing furnace with close isothermal characteristics over the full length of the rod and in air or in a pure oxygen atmosphere. The oven consists of a high-frequency induction heater oscillating at 20 mc. At this frequency it is possible to load directly into a tube of either zirconia or thoria. Under these conditions, the zirconia will reach about 4,900°F and thoria about 6,300°F. The inside diameter of the oven will accommodate laser rods up to 1 in. diameter. Units are available up to 100 kw and the output of the RF oscillator is controlled through powerstats, thyratrons or saturable reactors Monitoring devices are to customer specification.

Circle No. 226 on Subscriber Service Card

Pilot Lamp

A miniature, 120-v pilot lamp for use in standard voltage circuits without auxiliary equipment is available from the Lighting Products Division of Sylvania Electric Products, Inc. The extended service lamp is engineered to provide a minimum of 3,000 hours of static life at its full rated voltage. It does not require resistors or transformers when used on 120-v circuits. Environmental reliability makes lamp survival possible under 2½-g shock at a vibration sweep of 5 to 500 cps.

Circle No. 227 on Subscriber Service Card

Tone Filters

A line of high and low Q tone filters s being introduced by Control Science Corp. These filters and related discriminators employ the classic circuit in which a frequency determining network becomes the feedback arm of an operational amplifier. This "active" ilter has greatest application at the low nd of the spectrum. Normally, filters are supplied with output voltage equal o input. However, the gain is adjustable in production, which enables the user to specify input and output voltages over a wide range. Control Science's tone filters offer the following design improvements: improved stability over a wide temperature range, narrow bandwidths (Q up to 500), very small total package, very low power drain, design flexibility.

Circle No. 228 on Subscriber Service Card

VHF Voltmeter

A sensitive VHF voltmeter designed for accurate true or rms measurements from 300 microvolts to 30v over a frequency range of 0.1 mc to 1,000 mc, is being marketed by Ballantine Laboratories.

The Model 340, has a 5-in. voltage scale that spreads out the voltage readings logarithmically. The unit measures voltages accurately regardless of waveform, and it can be calibrated using a signal source that may be far from sinusoidal.

Circle No. 229 on Subscriber Service Card

50-Kw Transmitter

The Electronics Div. of Westinghouse Defense Center has developed a 50-kilowatt high-frequency single-sideband transmitter.

The unit is completely housed in three standard cabinets, and is air cooled, provides automatic tuning over 10 preset channels, and has extremely low distortion. Silicon controlled-rectifiers and transistors are used in all power supplies.

Circle No. 230 on Subscriber Service Card

Automatic Synchro/Resolver

A test setup that automatically checks angular accuracy of synchros and resolvers has been developed by Gertsch Products, Inc.

The test set employs an automatic dividing head, a phase angle voltmeter, and a programmable synchro/resolver standard or bridge.

Equivalent angular error is displayed on the phase-angle voltmeter. If error exceeds preset limits, an optional meter relay provides contact closures which automatically stop tests, and light a warning signal on the go/no-go indicator. In addition, the recorder provides a permanent record at each 5° step. Seven minutes are required for a complete 72-point test.

Circle No. 231 on Subscriber Service Card

Accelerometer Calibrator

An accelerometer calibration system, offering an accuracy of ±2.5% has been developed by ITT Industrial Products Div. of International Telephone and Telegraph Corp.

The Model CS 101 introduces a probable error of 0.7% over the frequency range from 20 to 3,500 cycles. When used with a reference accelerometer standard calibrated to ±1% by the National Bureau of Standards, the total possible system error will be less than 2.4%, while the probable error of the calibration is specified as 1.2%.

Circle No. 232 on Subscriber Service Card

Thermoelectric Cascade Unit

A thermoelectric cascade unit with matched power supply—a complete two-stage heat pump that heats or cools to provide a constant temperature throughout a wide range of conditions—is available from the Special Products Department of the Westinghouse Semiconductor Division. The unit, W832G03, provides a −58°F cold side temperature while cooling a 400-milliwatt load. It is designed to operate with 24 amps of dc device current. The rating is based on an ambient temperature of 75°F. The unit has an even greater cooling capacity when operating under conditions where the temperature difference between ambient and cold side is less. The cascade unit is ideal for use in apparatus for freezing point measurements, dew point meters, freezing traps, photomultiplier tube coolers and many other low-temperature applications.

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Universal Transistor Tester

A transistor pulse tester for checking a wide variety of transistors has been developed by the Leland Airborne Products Div. of American Machine & Foundry Co. The unit is designed for receiving inspection where different lot sizes and types of transistors require verification of specifications.

The 300-microsecond, 2% duty-cycle, pulse technique used permits high power testing with minimum heating. Parameters measured are: dc current gain; collector-to-emitter saturation voltage from 100 mv to 10 volts; base-to-emitter forward voltage drive from 100 mv to 10 volts.

Circle No. 234 on Subscriber Service Card

Hermetically Sealed Switches

A series of rotary selector switches featuring hermetic seal construction yet capable of continuous rotation in either direction is available from Janco Corp. Designated the Series 15-1900, these units will meet applicable military specification conditions for true hermetically sealed units, and provide protection against explosion, corrosion, dust and fungus.

Circle No. 235 on Subscriber Service Card

Magnet Dewar

Developed by Sulfrian Cryogenics, Inc., the 30-liter dewar features a loss rate of below 75 cc of liquid helium per hour.

The vessel is used for superconductivity studies and for research into electronic microminiaturization that also permits "tunnelling" studies of metals at temperatures down to 4.252°K. The findings can result in extremely small, highly dependable amplifiers, oscillators, switches and memory devices.

Circle No. 236 on Subscriber Service Card

Energy Storage System

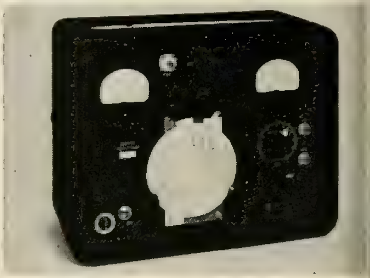
Radiation at Stanford has announced availability of a new energy storage system (Series 1210) capable of providing, on a modular basis, up to 144,000 joules of electrical energy for use with high energy, optically pumped lasers. The system consists of a series of components, each of which is available separately or in combination. Basic building block of the Series 1210 is a 12,000 joule, 5 kv capacitor module with energy storage increments of 1,000, 2,000 and 3,000 joules.

The modules are available in two types. The first (Model 1210-CM1) contains four 3,000 joule capacitors with associated charge/discharge resistors and fuses. The second (Model 1210-CM2) is designed to provide greater flexibility in selection of energy per lamp and incorporates two 3,000 joule capacitors and two dual capacitors with a 1,000 and a 2,000 joule section. Individual module control allows each module to be set to a different charge voltage.

Circle No. 237 on Subscriber Service Card

Signal Generator

Ferris Instrument Co. has available the Model 18M Microvolter, a continuously tunable signal generator covering the entire RF spectrum from two to 250 mc, offering single-instrument accommodation of a broad variety of services including short wave, and VHF television.



The direct-reading frequency dial, and the auxiliary vernier logging dial offering 1,000 divisions for each band, are individually calibrated for an accuracy of better than 1% for all frequencies.

Circle No. 238 on Subscriber Service Card

Metal-Film Resistors

Key Resistor Corp. has announced a line of multiple epoxy-coated metal- and carbon-film resistors, the "Key Kote." The metal-film (BM Series) resistors feature high-temperature solder brazed terminations and low temperature coefficients; these units are produced through an entirely automated process.

Key's BM Series of metal-film resistors is available in six different types BMA thru BMF. The wattage ranges from 0.1 w @ 125°C to 1 w @ 125°C voltage from 100 to 500 vdc; and resistance ranges of 100 ohms to 100K (Type BMA) to 100 ohms to 2 meg ohms (Type BMF). Built to meet or exceed the specification requirements of MIL-R-10509D (characteristics C, D and E), these highly stable resistors are available in T-9, T-2, and T-0 temperature coefficients and 1% standard tolerances.

Circle No. 239 on Subscriber Service Card

High-Power Transistor

A low-cost, high-power germanium power transistor, the 2N1970 in a TO-36 package is being marketed by Delco Radio Div., General Motors.

The unit is for use with 12v power supplies where high voltage transients are encountered. It is characterized by a maximum continous emitter current of 15 amperes, maximum collector diode rating (vcb) of —100v and a hermal resistance rating of 0.5°C (junction to case). It also features low aturation resistance and low vbe for igh efficiency in switching applicaions. The case is hermetically sealed or added reliability.

Circle No. 240 on Subscriber Service Card

ight Dependent Resistor

A light-dependent resistor with high ower handling capabilities has been leveloped by the Delco Radio Div. of eneral Motors.

One advantage of the LDR-25 is hat it permits elimination of relays vhere the current required to operate olenoids is of the order of 0.5 amp., nd can be used as a speed control for ractional horsepower motors.

The device is constructed of a thin ayer of sintered semiconductor applied o an aluminum oxide substrate. The ower photocell is intended primarily or medium or high-power switching nd control applications where turn-on nd turn-off times of the order of tens f milliseconds can be tolerated. The evice is designed to operate directly rom 110v ac and is conservatively ated at 200v dc or peak ac.

Circle No. 241 on Subscriber Service Card

Miniature Transformers

Arnold Magnetics Corp., has anounced a series of miniature, singlehase, 400-cps transformers with 1, 2, outputs from 1 to 1000 volts. Input 400 cps at 115v ac, rated 1.0 to 20 atts.

Designated the TT series, units are esigned to meet the requirements of IIL-T-27A and MIL-E-5272D. Transormers are encapsulated in flame-reırdant epoxy, permitting operation in temperature range of —55° to 100°C. se of a toroid design results in thinner, nore rugged units with higher wattensity, and less sensitivity to stray agnetic fields than conventional transormers. Low phase shift is achieved rough tight electrical coupling.

Three terminal configurations are vailable—printed circuit board, solder sembly, and stacking on a single rew for chassis mounting. Sizes: from 5 in. high x 1.062 in. dia. to 11.25 in. gh x 1.625 in. dia. Weights: from 0.5 3.9 oz.

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our ears are "UP"

...to track, monitor, and measure spacecraft and missile performance of every launch at the Atlantic Missile Range.

For instrumentation engineers with Pan Am's Guided Missiles Range Division, this means the planning and design of new sensor systems to meet the demanding radar and telemetry requirements of each new mission—Gemini, Apollo, Satellites, Space Probes. These next generation instrumentation systems will provide greater coverage, accuracy, mobility, reliability and automated real-time data delivery.

Examples of diverse approaches being taken to achieve such systems are:

- a new CW doppler range-rate tracking system that measures missile and spacecraft velocity with accuracy of 0.5 fps.
- pulse doppler radars that measure range rate to 0.1 fps.
- large high-gain (85 ft. diam.) wide-band (130-2300 mc) automatic tracking antenna systems
- advanced, universal pulse code modulation (PCM) ground systems (bit rate from 1 to 1 million bits per second).

Engineers interested in joining in this effort are invited to write in confidence to Dr. Charles Carroll, Dept. 56H-1.

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Circle No. 5 on Subscriber Service Card

Encoders

Kearfott Div. of General Precision Aerospace has available a series of Size 11 encoders that can have up to 50,000 pure-binary-code sampling rates per minute for outputs of 0 to 999, 0 to 9,999, 0 to 99,999 and 0 to 359.9°. Each encoder contains "OR" gating and is designed for serial interrogation to allow sharing of selection logic and encoders. Design features incorporated into these units include solid gold alloy drums and brushes, in-line brush geometry, continuous gearing, and flush conducting and nonconducting drum surfaces. Noise characteristics of these encoders is less than 10% of the leading edge of least significant bit, torque is 0.3 in.-oz. max.; inertia is 25 gm cm^2; accuracy is ±½ bit; life is 5×10^6 cps at 500 rpm (can be increased to 8×10^6 cps); and they operate in the temperature range of −55°C to +125°C.

Circle No. 243 on Subcsriber Service Card

Fire-Control Facility

A digital Fire Unit Integration Facility (FUIF), which provides a reliable data-processing and communications link between existing electronic air-defense systems and the guided missile batteries they coordinate, has been developed by Martin Co.

The digital FUIF is designed so that it can operate with Missile Master, Birdie, Missile Monitor or similar air defense systems, and *Nike, Hawk* or comparable missile fire systems. The unit operates over wire or radio links with equipment employing standard 59-bit, 750-bit-per-second data frame using either pulse coded modulation or frequency shift modulation data. The equipment can be adapted to higher speed data links and various message structures. A minimum number of plug-in printed circuit cards, which can be replaced in seconds, are used in the equipment.

Circle No. 244 on Subscriber Service Card

Water-Cooled Flashtube

An addition to the EG&G line of xenon-filled, laser flashtubes is the water-cooled FX-65, which can be cooled with ordinary tap water. The need for demineralized water as a low voltage-leak preventive has been eliminated by incorporating two separate cooling systems, one for the envelope and one for the end caps. Water flow is approximately one gallon/min., with an average power of 8kw. The new tube's maximum input per flash is 2,000 joules for a 6-in. arc length and 7-mm discharge bore. Minimum operating voltage is 1.5kv, trigger voltage is 25kv and the life of the tube is more than half a million flashes. Another new water-cooled tube, the FX-62, will also be shown at Wescon by EG&G. It is a 600-joule, 4-kw unit with a 3-in. arc length. It is similar in construction to the FX-65.

Circle No. 245 on Subscriber Service Card

Miniature Duplexer

E&M Laboratories, Van Nuys, Calif., has announced the availability of a series of miniature iso-circulator duplexers suitable for medium power use.

The Model X101LTI duplexer has been specifically designed to cover the commercial and beacon frequency range of 9375 ±50mc and will handle a minimum of 50 kw peak to an altitude of 40,000 feet. Isolation between the antenna and transmitter is greater than 40db. Insertion loss from antenna to receiver is 0.4 db maximum and the VSWR to the transmitter port is 1.10 maximum.

Duplexers covering broader bandwidths, other frequency ranges, and higher power requirements are also available.

Circle No. 246 on Subscriber Service Card

Half-Rack DC Power Supplies

Trygon Electronics has available a medium power half-rack series of regulated d-c power supplies designed for laboratory and systems applications. The new series consists of four models —0-20v dc at 5a, 0-40v dc at 2.5a and 0-60v dc at 2.5a. Line and load regulation is better than 0.01%, with ripple held below 0.5mv RMS.

Design allows the units to be packaged in a small, half-rack configuration for bench applications. Rack adapters convert the supplies to systems units by housing two supplies in 5¼ in. of rack space.

Circle No. 247 on Subscriber Service Card

Low-Current Unit

Fully automatic current measurements from 0.999 ma. through 999 picoamperes are possible using a low current unit developed by the Industrial Products Group of Texas Instruments.

The device provides full-scale accuracy of 0.5% and is intended for use with the firm's TACT (Transistor and Component Tester) systems.

Circle No. 248 on Subscriber Service Card

Advanced
Command & Control Systems
Design Engineer

A high level position is now available with Bell Aerosystems Co., a company holding a variety of advanced contracts including a lunar landing research vehicle, exotic instruments, battlefield air traffic controls, mapping systems and learning machines.

The man selected will be responsible for analytical and preliminary design studies of command and control systems for terrestrial and orbital vehicles, accurately defining system requirements and limitations. Specific areas of investigation include position determination, vehicle control, data processing and transmission, and information display.

The demands of the job to be done require an advanced degree in Physics or EE with minimum 8 years related experience, plus knowledge of military system design requirements. Salary to $18,000.

Please send resumes, in confidence, to Mr. Thomas Fritschi, Dept. C-32.

ba

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Sensomatic Control

The Sensomatic Div. of Weldotron Corp. has added the Model 500 to its line of electronic controls for automatic machine operations. This control can be used to monitor up to four malfunctions simultaneously: material misfeed, buckling, twisting or end of run. Transistorized for high reliability and lower consumption, the Sensomatic 500 will protect dies and parts, prevent material waste, and minimize down time. It will stop the machine within 6 milliseconds of malfunction detection. This instantaneous reaction permits faster machine operation and permits one operator to supervise many machines. Where desired, the Model 500 is available with a remote control station comprising "run" and "reset" indicators and a pushbutton reset. This will permit the monitoring of a battery of machines from one central point.

Circle No. 249 on Subscriber Service Card

Kilovoltmeter

Kalpa Scientific Laboratories, Inc., has available a dual instrument with 0-5kv/10kv/50kv and 100-kv d-c and 60-cycle a-c ranges. The unit has a 6-in. precision mirror scale meter and is completely transistorized with virtually zero drift amplification, which results in only a few microamperes drain on voltage being measured. It features a compensator which automatically provides for voltage coefficient correction of multiplier resistors, and has special spike bypass circuitry to make it insensitive to overloads up to 100%.

Circle No. 250 on Subscriber Service Card

Pulse Transformer

A reduced-volume version of PCA Electronics' TT series of pulse transformers is available on special order for applications in missile, telemetry and communication systems where space is at a premium. Occupying only half the area of PCA's standard TT pulse transformers, this miniaturized version has no measurement exceeding ³⁄₁₀ of an inch. Available with two or three windings, these custom manufactured units have inductances between 60 nanohenries and 5 millihenries, with a maximum rating of 50 v dc. Employing a highly stable core of grain oriented silicon steel, these miniature transformers are said to possess high temperature stability and are encapsulated in flame-resistant, moisture-retardent epoxy resin coating.

Circle No. 251 on Subscriber Service Card

Serial Converter

The Model 265 solid-state high-speed serial converter developed by Non-Linear Systems, Inc., is designed for converting parallel digital data to serial form in data logging applications using tape punches or magnetic tape recorders.

The device has a built-in memory which permits it to acquire new information while feeding previously gathered information to the tape punch or recorder. Thus, data are recorded continuously at full tape punch speed of 110 characters per second.

The converter offers a word length of up to 14 characters in the standard unit. Up to 18 characters can be contained in the same package, and capacity may be expanded to 28 characters with an auxiliary chassis.

Circle No. 252 on Subscriber Service Card

Analog-to-Digital Converter

Dynamic System Electronics is marketing a militarized version of its ADC-1 analog-to-digital converter in a smaller package. The unit is designed for airborne military and space use, meeting the requirements of MIL E-5272C specifications. Input analog: Accuracy, ±0.5%; resolution, ±1 part in 255; speed, 1,000 conversions/second

Proven as a standard-scan camera, transmitting a continuous, clear picture of the Echo balloon openings; *proven* as a slow-scan camera, successfully monitoring the liquid hydrogen effect inside Centaur fuel tanks; *now ready* as a flexible-scan camera, adjustable to your required scanning rate... the Lear Siegler Missile-borne Camera offers a broad range of capabilities to meet your "TV-in-space" requirements. Camera unit is 2.5" dia. x 8". Control unit is 9" x 6.2" x 3.9". Total weight is 7.5 lbs. *Send us your special requirements for low light level, auto-track, missile guidance, missile-borne, or ground video systems.* Electronic Instrumentation Division of Lear Siegler, Inc., 714 N. Brookhurst St., Anaheim, California.

LSi

LEAR SIEGLER, INC.

ELECTRONIC
INSTRUMENTATION DIVISION
Formerly Hallamore Electronics Division

Circle No. 6 on Subscriber Service Card

maximum; input impedance, 10 K ohms; Digitizing time, 1 millisecond; Sensitivity, one microamp/bit. Output digital; Code, binary 2's complement; mode, parallel; bits, 8 including polarity; Voltage, 0 and —6 volts; current, 1 milliamp; conversion, complete pulse.

Circle No. 253 on Subscriber Service Card

DC-AC Choppers

Stevens-Arnold Inc. is manufacturing miniature, low-noise, dc-ac choppers for instrument use. Mounting has been designed for printed circuit boards where height is at a premium. To assure reliability, precious metal contacts are used and these are arranged in duplicate. Wide band noise has been minimized to less than 1 microvolt across a 100,000 ohm load. Both SPDT and DPDT models are available. For ac operation there are 50/60/94 cycle types. For dc operation transistorized driver units can be furnished to convert 12 volts dc into 94 cps square waves, for operating the chopper. Uses include: analog-computer amplifiers, precision regulated power supplies, automatic-balancing strain-gauge bridge circuits, and self-balancing potentiometers.

Circle No. 254 on Subscriber Service Card

Mass Spectrum Digitizer

Available from Adage Co., the mass spectrum digitizer is an instrument for automatic digital readout and recording of mass spectrometer data.

The Model VR16-MSD is capable of detecting and measuring more than 1,000 peaks per second, but is limited in practice by the response of the mass spectrometer detector amplifier and the speed of the recording device used. Up to five peaks per second are routinely measured and digitally recorded. Specifications include: input voltage range A (from detector amplifier) 0.000 to —9.999v, range B (from accelerating voltage attenuator) 0.000 to 9.999v.

Circle No. 255 on Subscriber Service Card

20-Joule Laser

Korad Corp., a subsidiary of Union Carbide Corp., is marketing the Model K-1, a complete ruby laser system for experimental work.

The device has a typical pulse energy output of 20 joules at room temperature. It is designed especially for experimental studies in optical radar, communications, radiation effects, micromachining and photography.

The head is a laser oscillator featuring external mirrors and may be easily operated as an amplifier. The system is also compatible with Q-spoiler equipment.

The electronic portion of the system provides energy storage, high voltage, and complete controls for manual or automatic triggering.

Circle No. 256 on Subscriber Service Card

Geodimeter

The AGA Corp. has developed the Model 4D geodimeters for measuring up to 15-20 lines per day in full daylight. Lengths of lines vary from 50 ft. to two miles and more.

The accuracy of the unit is 0.04 ft. ±2 millionths of the distance, a ratio in excess of 1:20,000 on lines of 1,000-ft. length, or 1:105,000 on one mile.

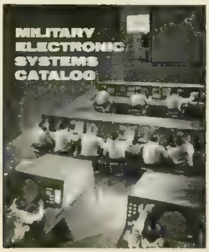
The device is designed for daylight measurement, which can be accomplished by its new light source, a mercury arc lamp, and provides operation at dusk of 5-10 mi. and at night on lines as long as 15-20 mi.

Circle No. 257 on Subscriber Service Card

Solid-State Amplifier

A solid-state, chopper-stabilized operational amplifier in modular form for use in analog computer and data reduction systems is available from Astrodata, Inc. Designed specifically for fast settling time, low offset and low noise, Model 117 plug-in units use field-effect transistors in the input stages of the wide-band dc amplifier. Voltage offset drift is only 20 microvolts per day, current offset drift is only 1.5 x 10^{-11} amps per day. Fast transient response time permits settling to 0.1% of final value within 50 microseconds after a fullscale (±100 volt) step. Other important specifications are: open loop gain, greater than 100 million; input resistance, greater than 3 megohms; frequency response, dc to 100 kc.

Circle No. 258 on Subscriber Service Card



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Thermistor Micro-Beads

Victory Engineering Corp. has anounced production of a new line of ery small (0.005-in. dia.) thermistors, alled Micro-beads. Resistances availble, measured at 25°C, are 1,000 ohms o one megohm. Leads are ¼ in. min. ength by 0.0007-in. dia. platinum-iridum alloy wire. An example of VECO's ew Micro-bead series is the 32A402, ith and R_o of 2,000 ohms ±25%. It ffers a dissipation constant in still air f 0.045 mw per degree and a time onstant of 0.12 seconds, also measured n still air. Negative temperature cofficient is —3.4%C at 25°C.

Circle No. 259 on Subscriber Service Card

VLF Receiver

The Model 1310 VLF phase tracking receiver available from RMS Enineering, Inc., provides a means of dermining the accuracy of a frequency andard to parts in 10^{11}. This instrument uses VLF stabilized transmissions or comparison with local frequency andards, and supplies a readout dictly in microseconds of the cumlative error of the local standard with espect to the received reference. In adtion, an output is provided to drive a rip chart recorder. An offset as small one part in 10^{10} can be determined ith this unit in approximately three ours.

Circle No. 260 on Subscriber Service Card

Microwave Switch

Microwave Associates, Inc., is marting a double-pole, double-throw solidate microwave switch. The MA-8313-LIND operates over a frequency range 700 to 1,600 mc, with peak power pabilities of 500 watts and a CW ower capability of 4 watts. The device s a switching speed of less than 200 noseconds. It was originally designed a lobing switch for radiometer noise ference because of its low loss and inimum amount of generated noise. ne switch also finds application in varis test equipment uses. The MA-8313-LIND can include a driver that enables e switch to be operated from a 110v, cycle ac source.

Circle No. 261 on Subscriber Service Card

ower Equalizer

A power equalizer for use with velling wave tubes has been developed Sanders Associates, Inc., Microwave oducts Dept.

Fabricated in strip transmission line, device is designed for use where re is an uneven output of power er a frequency bandwidth. The model 56, covering a frequency range of to 4 gc, has a maximum VSWR of ; directivity is 15 db minimum and insertion loss is 0.5 db maximum at 2 and 4 gc; 1.0 to 2.0 db at 2.5 and 3.5 gc and 2.3 to 2.8 db at 3 gc, and meets MIL-E-5400 D specifications.

Circle No. 262 on Subscriber Service Card

Varactor Multiplier

A varactor frequency multiplier, with broadband operation and octave tuning, is being marketed by the Telonic Engineering Corp.

The solid-state, passive multiplier has an output range of 1 to 2 gc for inputs from 500 mc to 1 gc. Its output is flat within ±5 db, with a bandwidth of 15% over the entire tuning range of 1 to 2 gc.

Nominal input power rating of the TTM-1 is two watts with a conversion loss of only three db. Input and output filtering attenuates all spurious harmonics by a minimum of 30 db.

Circle No. 263 on Subscriber Service Card

3-KV Pulse Modulator

Manson Laboratories, a subsidiary of the Hallicrafters Co., has available a pulse modulator with outputs from 0.2 kv to 3 kv peak, continuously variable, and rise and fall times of no more than 30 nanoseconds.

The Model 751 is designed for application in the development and test of low power beacon-type magnetrons with pulse widths as short as 0.05 microseconds. Negative or positive pulse outputs are supplied in any duration from 0.05 to 1.0 microsec. at any repetition frequency from 10 cps to 15 kc. All pulses are generated within the equipment.

Circle No. 264 on Subscriber Service Card

Six-gun Tube

A six-in-one electron gun as part of a cathode ray is being manufactured by Electronic Tube Division of Sylvania Electric Products for use in airborne countermeasures equipment.

The use of multi guns makes possible simultaneous displays on one 10 x 12 in. rectangular tube face plate. The complete tube features monoaccelerator design for excellent pattern linearity and electrostatic deflection and focus. The six-gun mount is approximately 7 in. high. The complete tube is 21 in. long.

The tube has an encapsulated mu metal shield, and color-coded leads are brought out through the encapsulation. The component has a 4 kv anode voltage and is available in P-7 phosphor. Deflection factors are 1D2 for 80 to 100 volts and 3D4 for 38 to 50v dc per inch.

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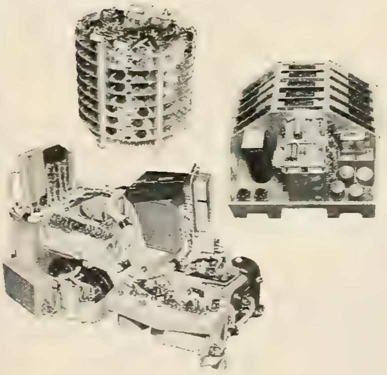

contracts and procurements

AWARDS

AIR FORCE

$4,300,000—**University of Michigan**, Ann Arbor, for erection of a ballistic missile observatory on the island of Maui, Hawaii.

$1,300,000—**Stearns Rogers Corp.**, West Palm Beach, Fla., for operation of gas-producing plants for space applications.

$1,200,000—**Sperry Rand Corp., UNIVAC Div.**, Washington, D. C., for programming, maintenance and documentation related to "Athena" computers.

$1,150,000—**Sperry-Piedmont Co.**, Charlottesville, Va., for electronic gear which would permit two missiles to be launched simultaneously from Cape Canaveral, and additional countdown and associated tests.

$700,000—**Pickard & Burns, Inc.**, Waltham, Mass., for an atomic frequency standard which surpasses the accuracy and reliability of existing equipment.

$356,984—**Avco Corp., Everett Research Laboratory**, Everett, Mass., for plasma propulsion.

$284,200—**North American Aviation, Inc., Space and Information Systems Div.**, Downey, Calif., for supplemental acquisition and installation of facilities in support of the *GAM-77* missile program.

$184,000—**General Dynamics Corp., Electronics Div.**, Rochester, N.Y., for development of a dynamic error-free transmission (DEFT) system to provide digital data transmission by HF radio with a minimum of error.

$140,000—**Cubic Corp., Temec, Inc.**, San Diego, Calif., for two EV-9 UHF antenna systems for installation in Japan and Pakistan.

$105,195—**Stanford Research Institute**, Menlo Park, Calif., for revision of the syllabus of on-site inspection and continued research and development on visual and photographic on-site inspection techniques (two contracts).

ARMY

$745,000—**Ryan Aeronautical Co.**, San Diego, for continuation of contractor-operated services at White Sands Missile Range, N.M.

$545,014—**Martin Marietta Corp.**, Orlando, Fla., for repair parts for the *Pershing* missile system (four contracts).

$219,623—**ITT Federal Laboratories**, Nutley, N.J., for engineering services, including repair and alignment, of satellite communications terminals.

$211,758—**Baroco Electrical Construction Co.**, for an electrical transmission system for servicing the rocket test site at the Marshall Space Flight Center's Mississippi Test Facility.

$204,868—**Overland Construction Co.**, Vero Beach, Fla., for a missile instrumentation station.

$199,000—**Bendix Corp., York Div.**, York, Pa., for research and development work on the *Mauler* missile weapon system's fuze.

$148,241—**Bausch & Lomb, Inc.**, Rochester, N.Y., for a radar image correlation viewer.

Radio Corp. of America, Surface Communications Div., Camden, N.J., for design of a communications control center for the Army's satellite program (undisclosed amount).

Foote Mineral Co., Exton, Pa., for a study of improved neutron attenuating glasses.

NAVY

$6,000,000—**Western Electric Co.**, New York City, for the development of a new Pacific Missile Range telecommunications transmission system.

$2,700,000—**Sperry Rand Corp., Sperry Gyroscope Co.**, Great Neck, N.Y., for radar sets.

$2,000,000—**Missile Systems Corp.**, Dallas, for production of launchers.

$1,500,000—**Bendix Corp., Mishawaka Div.**, Mishawaka, Ind., for continuation of research and development on the medium range *Typhon* missile.

$1,200,000—**Bendix Corp., Field Engineering Corp.**, Detroit, for work on surveillance equipment.

$1,000,000—**Lear Siegler, Inc.**, for undersea and aerospace devices, including components for a cloud height radar system for weather forecasting. Work to be performed at Long Island City, N.Y., and Deep River, Conn. Contract awarded by Navy, Air Force and Cambridge Research Laboratory.

NASA

$624,000—**Lockheed Aircraft Corp., Missiles and Space Div.**, Sunnyvale, Calif., for production of *Agena* second stage space vehicles.

$400,000—**North American Aviation, Inc., Atomics Div.**, Canoga Park, Calif., for research in space-age metals which could lead to more reliable spacecraft power supplies.

$263,331—**Westinghouse Electric Corp.**, Baltimore, for feasibility and parametric design study of the application of a station-keeping system to passive communications satellites.

$191,849—**Goodyear Aircraft Corp.**, Akron, Ohio, for a feasibility study of a gravity gradient stabilized lenticular satellite.

$176,700—**Chicago Bridge and Iron Co.**, Cleveland, for service, labor and material to fabricate and erect a 20,000-gallon liquid hydrogen research vessel.

$144,500—**California Computer Products, Inc.**, Anaheim, Calif., for *Nimbus* maintenance and operating ground station equipment.

$142,850—**General Dynamics Corp.**, San Diego, for studies to determine the measurement of neutron spectra in liquid hydrogen.

$100,000—**Livingston Electronic Corp.**, Montgomeryville, Pa., for an investigation of electrochemical systems suitable for the production of high energy batteries.

INDUSTRY

$11,200,000—**Textron's Bell Aerosystems Co.**, Buffalo, N.Y., from **Grumman Aircraft Engineering Corp.**, for design and building of an ascent rocket engine.

$2,800,000—**Avien, Inc.**, Woodside, N.Y., from **North American Aviation's Space and Information Systems Div.**, for development and production of an optical communications antenna system for the *Apollo* lunar mission.

$1,964,829—**Electronic Associates, Inc.**, Long Branch, N.J., from the **Martin Co.**, for 11 large-scale analog computing systems.

$1,700,000—**H. C. Smith Construction Co.**, Los Angeles, from the **Boeing Co.**, for installation and construction work in Missouri for the fourth wing of Air Force *Minuteman* missiles.

$1,500,000—**Daniel Construction Co.**, Orlando, Fla., from **Martin-Orlando**, for two new buildings at Martin-Orlando's facilities.

$1,400,000—**Merritt-Chapman & Scott Corp.**, Miami, from **Aerojet-General Corp.**, for design and erection of a solid rocket motor facility at Aerojet-General's Miami plant.

$1,400,000—**Radiation, Inc.**, Melbourne, Fla., from the **Martin Marietta Corp.**, for development and production of an airborne telemetry system for the *Titan III* space booster.

$1,000,000—**Moog Servocontrols, Inc.**, East Aurora, N.Y., from the **Martin Co.'s Denver Div.**, for production of servocontrols for steering all three liquid stages of the *Titan III* booster system.

$1,000,000—**Rocket Power Inc.**, Mesa, Ariz., from the **McDonnell Aircraft Co.**, for design and development of a special rocket motor for the escape-ejection system to be used in the TFX fighter aircraft.

$800,000—**United Electrodynamics, Inc.**, Pasadena, Calif., from the **Boeing Co.**, for flight test telemetry equipment for the *Minuteman* weapon system.

$770,000—**Eitel-McCullough, Inc., Microwave Tube Div.**, San Carlos, Calif., from **Sandia Corp.**, for traveling-wave tube telemetry modules.

$750,000—**Systems Engineering Laboratories, Inc.**, Fort Lauderdale, Fla., from **North American Aviation, Inc.**, for an advanced data acquisition system to be used in the *Apollo* program.

$500,000—**Williamette Iron & Steel Co.**, Portland, Ore., from the **Boeing Co.**, for production of parts for the *Minuteman* weapon system and fabrication of castings for the launch facility closure system.

$400,000—**Aerotest Laboratories, Inc.**, Deer Park, N.Y., from **Jet Research Center, Inc.**, for testing the thrust termination systems to be employed on the *Titan III* booster system.

$60,000—**Products Research Co.**, Glendale, Calif., from the **Boeing Co.**, for a moulding and potting compound for use in the electrical system of the *Minuteman* ICBM system.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations to be conducted with Pennsalt Chemical Corp., Philadelphia 2, Pa., for expansion of Contract AF 33(657)-8461 to provide for short term compatibility testing of new candidate rocket fuels and oxidizers. Note: For information only. No RFP available. PR-189928-R-20

National Aeronautics and
Space Administration
Wallops Station
Wallops Island, Va.

Convert the RT-2 telescope into a meteor telespectrograph and to measure the dynamic characteristics of its tracking system. Job—RFP P-753. RFP due date 8-19-63. This constitutes the first step of a two-step formally advertised procurement.

Procurement & Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Liquid carbon dioxide. Delivery to George C. Marshall Space Flight Center, Huntsville Ala.—1 item. IFB MSFC 64-17. Bid opening 8-6-63.

Directorate of Procurement and Production
(SAPOSS)
Kelly Air Force Base, Tex.

2915-048-7157 (P/N 10130D) carburetor—36 each. Applicable to 0Q19 target missile. No drawings or specs are available. Deliver Pueblo Army Depot (A51714), Pueblo, Colo. RFP MIRP D1 3-26173 (Q). Item identified by McCullough Corp., 6101 West Century Blvd., Los Angeles Calif., part number. Direct inquiries to M. C Cantrell, WAlnut 3-5411, Ext. 5203, Kelly Ai Force Base.

(Continued from page 27)

- **System size**—To obtain maximum viewing angle, a range of rim diameters and mirror openings can be used, with opening sizes ranging from 5mm to 3 in., and rim diameters proportionately scaled from 12 to 24 in.

The smallest size aperture figure is actually limited by the size of the human eye pupil under minimum light conditions, says Glaser, who also notes that the smaller the opening, the more precise must be the positioning of the viewer's eyeball or optical system.

The degree of image brightness depends on rim diameter and aperture size, which can be chosen from the available values when specific mission plans are known. In lab tests, Glaser says "visual observations made with a system having a 12-in. rim diameter and a mirror opening of 1 in. showed images of distant objects to be clearly discernible."

Design of the system (see illustration) is such that radiation from an object enters the opening in the outer paraboloid and strikes the surface of the inner one. It is then reflected from the inner mirror surface to the outer mirror surface. From there, it is reflected at an angle which converges to form the real image within the system.

In this manner, objects outside the optical system at various distances and angles off the optical LOS appear as real images at various points between the two mirrors, with the images subtending the same angle at the viewer's eye as the real object. For example, images of objects at infinity off the optical LOS would lie very near the outer mirror surface.

Glaser also points out that the system's ability to provide true images within the device may make it useful for roles other than observation. Since the system reflects virtually the entire spectrum radiated by the source (depending on mirror coating), its radiation can be measured by various sensors, opening the way to its use as a precise range finder or as a means to measure object temperatures.

Because the image of the scene being viewed by an observer is inverted, some form of optical system is required in an operational device to display the view to an astronaut in a correct relationship and bring it to the most suitable spacecraft location.

- **Associated optics**—The type of system that could be used with this window is now one of the points being studied at North American Aviation, Inc., *Apollo* prime contractor.

Glaser suggests a number of optical means are available but feels the optimum solution probably lies in use of a narrow-angle viewing system with a scan capability to bring the entire view into use. He says this could be accomplished with an optical system with perhaps a 70-degree angle-of-view linked to a fiber optics or coherent light pipe setup, with the scanning motion of the crewman's head transferred by servomechanisms to control the scan of the lens system. Another possibility is scanning with a TV orthicon and use of a TV projection display.

Glaser generally favors the narrow angle plus scan concept over use of a wide-angle optical system, since it would preserve the inherent distortion-free imagery provided by the compound mirror system.

Glaser says the principles of this type of mirror system have been demonstrated in a thermal imager at the Air Force's Cambridge Research Laboratories, and the basic concept for the compound system was suggested by AFCRL's George P. Ploetz.

The type of optics and display that could best be used with the ADL system, its integration within the space vehicle, and human factors problems involved in pilot training are the most pressing points associated with its changes for use. NAA is now conducting a preliminary study with the device, looking into many of these matters, and attempting to fully explore the concept.

At this point, the concept is said to have greater acceptance among those charged with heat shield design than with those concerned with window and visibility problems.

Although Glaser feels the system, possibly using a TV display, also offers advantages for a Lunar Excursion Module-type vehicle with several square feet of picture window area, it is not too likely to be included in LEM, which faces no critical re-entry heating.

Engineers at Grumman Aircraft Engineering Corp., LEM contractor, told MISSILES AND ROCKETS they will keep the ADL concept in mind, for possible use in some back-up role for a portion of the LEM visibility system. "We've seen lots of clever optical schemes," says one engineer, "but windows still look like the simplest device and the one the pilot likes best. From a human factors standpoint, they'd probably rather not look into a sophisticated device while flying the machine."

LEM window problems are associated mostly with possibilities of lunar dust adhesion, micrometeorite strikes, and thermal radiation control during extremes of space flight and lunar operations. Use of shutters for the large LEM window area is a possibility. ■

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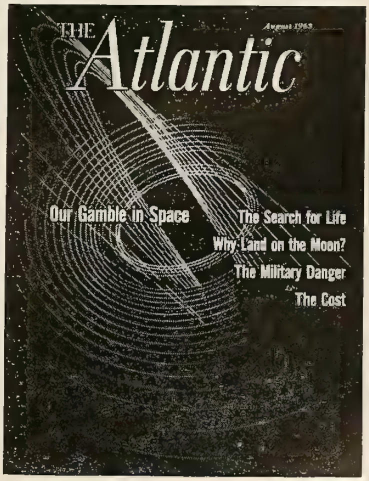

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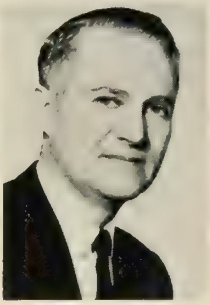
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Col. Sam Bruno (USAF Ret.): Joined Aerojet-General Corp., Sacramento, Calif., as manager of the Security Div.

M. Clayton Andrews: Appointed manager of the communications systems department of International Business Machines Corp.'s Federal Systems Div., Bethesda, Md.

George W. Mousel: Named assistant general manager of Perkin Electronic Corp., El Segundo, Calif. **J. Bruce Campbell** appointed sales manager.

Thomas J. O'Donnell: Appointed associate director, analysis and integration, Mobile Mid-Range Ballistic Missile Program *(MMRBM)* at the San Bernardino, Calif., operations of Aerospace Corp. **Mamoru Masaki** named manager, special studies, operational re-entry projects and **Renato Bianchi** appointed manager, Mark 15 re-entry systems program.

William E. Douglass: Appointed Alabama district manager for Westinghouse Electric Corp.'s Atomic, Defense & Space Group, Huntsville.

Robert V. Jordan: Appointed manager-market planning for the Electronic Tube and Microwave Device Division of Sylvania Electric Products, Inc., Seneca Falls, N.Y.

Fred E. Baetzman, Jr.: Appointed Washington, D.C., regional manager for Telemetrics, Inc., Gardena, Calif.

Joseph F. Clayton: Appointed director of planning for the Bendix Corp.'s Systems Div., Ann Arbor, Mich.

Otto C. Bixler: Joined the UNIVAC Div. of Sperry Rand Corp. as manager of defense operations, St. Paul, Minn.

Robert J. Siems: Named manager of the Boeing Co.'s customer liaison office in Omaha, Neb.

Edward T. Vilas: Named manager of the ballistic missile system branch at Vitro Laboratories, Silver Spring, Md. **Herbert A. Krivka** named to succeed him as head of the *Polaris* test department.

Charles L. Foss: Appointed general manager of Dresser Industries, Inc.'s electronic components division, Garland, Tex.

John H. Roseboom: Appointed vice president of Management Technology Inc., Washington, D.C.

Blair Bolles: Named vice president-government relations of Fairbanks, Morse & Co., Washington, D.C.

Dr. Jules S. Needle: Named chief engineer of the power grid tube division of Eitel-McCullough, Inc., San Carlos, Calif.

Bill G. Combs: Named district sales manager for northeastern United States for Century Electronics & Instruments, Inc., Washington, D.C.

Ivan E. Walenta: Joined the staff of Electro-Optical Systems, Inc., Pasadena, Calif., as a senior scientist in advanced systems engineering. **Edmund M. Digiulio** joined the staff as a senior scientist in advanced systems development operations.

Dr. George Gerard: Named vice president-research and engineering for the Concord, Mass., Laboratories of Allied Research Associates, Inc.

Harold Goldstein: Appointed director of engineering for Paradynamics, Inc., Huntington Station, N.Y.

Fielding G. Lucas: Named director of the Federal Systems Marketing Div. of Honeywell Electronic Data Processing, Washington, D.C.

Theodore G. Haertel: Appointed director of the industry planning service of Aerospace Industries Association, Washington, D.C.

John MacDonald: Appointed manager of sales and maintenance at Vapor Heating Ltd., Montreal.

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AUGUST

Eighth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 5-9.

Annual Industrial Research Conference, Columbia University, Arden House, Harriman, N.Y., Aug. 11-17.

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* and *Design News,* University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference, sponsored by NBS and Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

1963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug. 23.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries Seminar, sponsored by the Contract Management Institute, Clift Hotel, San Francisco, Aug. 26-30.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

Open Space and Peace Symposium, sponsored by the Hoover Institution on War, Revolution and Peace and Sylvania Electric Products, Inc., Stanford University, Stanford, Calif., Sept. 4-6.

Symposium on the Ellipsometer and Its Use in the Measurement of Surfaces and Thin Films, National Bureau of Standards, Washington, D.C., Sept. 5-6.

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

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Something for Boston

SENATOR TED KENNEDY is quoted as saying that, despite the setback by the Senate Space Committee, he still hopes the proposed National Aeronautics and Space Administration electronics center may be saved for Boston.

The Kennedy Administration has brought considerable pressure to bear on behalf of the center in an effort to help young Kennedy carry out his campaign promise of doing more for Massachusetts.

One Congressman goes so far as to call it an "affront to the intelligence of Congress."

The House Space Committee chopped more than $1 million from the $5-million request for the center and tied the remaining authorization to a requirement for further justification of the project. This specifies that no money may be expended until NASA has further justified both the need for the center and its location.

It is evident that NASA has not made a satisfactory case for the proposed electronics center in either space committee of Congress. Sen. Kennedy's reference to saving the center for Boston makes plain the reason why.

In the effort to snag this as a political plum for Boston, its backers have failed to prove the need for any center at all, regardless of location. If more attention had been devoted to proving that the nation needs the center and less to proving that Boston needs it, the proposal might have been more successful.

We frankly do not believe that the Fiscal '64 authorization bill for NASA should be regarded as a pork-barrel opportunity for the President's relatives. It is one thing to exert political pressure in favor of a specific geographical location for a project after a need for it is established. It is an entirely different and completely reprehensible thing to exert such high-level political pressure for a project which may not be needed at all.

We agree with the representative who calls it an affront to Congressional intelligence. We are glad to see members of both Houses standing up to the pressure of this ham-handed effort on behalf of the new Kennedy from Massachusetts.

There certainly has been an unhealthy air about the project from its inception. It is customary to first develop the requirement and authorization for such an establishment and then study possible locations. But from the first it has been made clear that this was to be a Boston electronics center. NASA also failed to present the customary architectural renderings to support the project—a hint that it might have been drawn up in some haste.

Even in the case of such a politically oriented site selection as Houston for the Manned Spacecraft Center, there was at least the outward form of a competition. No such competition was contemplated in the proposal for NASA's electronics center.

We do not regard as unethical the effort to spread the base of the space effort by distribution of contracts and NASA establishments throughout the nation—if quality and cost of the work do not suffer. Nor do we go along with those who are beginning to refer to it as the "Confederate Space Agency."

The growth of such NASA establishments as Marshall, Michoud, Houston and the Mississippi test site have a long-term and beneficial effect for the communities in which they are located, for the nation and for the space effort. The impact of the national space program on Southern communities, in particular, has been considerable. Educational standards are climbing, racial integration is being speeded, new technical skills are developing, and a wider industrial base is emerging. Prosperity is flowing into an area which was falling behind the rest of the nation in its industrial development.

These are legitimate considerations in the distribution of the many billions of dollars involved in the space effort. The wider spread of the space dollar also means wider political support for the expensive space program, a factor which has not been overlooked by NASA's politically astute administrator, James Webb.

IF NASA CAN PROVE a need for the new center —which it has failed so far to do—we suggest that advantages of its possible location elsewhere be studied. The Midwest, oriented to the long production runs of the automotive industry, has not easily made the transition into the research and development atmosphere of the missile/space industry. Might not the location of a NASA electronics center in the Midwest, where there is no extensive electronics industry, do much to stimulate both universities and industry in that area?

Boston, Southern California and the San Francisco area are strong electronics centers. Would not establishment of a NASA electronics center in the Midwest lead to development of a fourth electronics complex—just as location of MSC in Houston has stimulated growth of Space Age industry there?

The arguments which the Administration employs on behalf of the Boston site—its nearness to Harvard, MIT and electronics firms—would have applied equally well in a rejection of Houston for MSC.

Two questions about the electronics center still remain: Is it needed? Should it be in Boston? An affirmative answer to the first should not be regarded as an affirmative answer to the second. To date, however, no strong case has been made for an affirmative answer to either.

William J. Coughlin

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NaK—Designed the SNAP-8 heat exchanger for operation at 1300°F. Determined corrosiveness of NaK in columbium-stainless steel bi-metallic capsules at 700°F for 1000 hours.

MERCURY—Designed zero gravity boiler and radiator for SNAP-8; operated boiling Hg condensing loop to determine flow stability and heat transfer; determined solubility of containment alloys in Hg up to 1150°F; determined compatibility of alloys in Hg at temperatures up to 1250°F over a 10,000-hour period.

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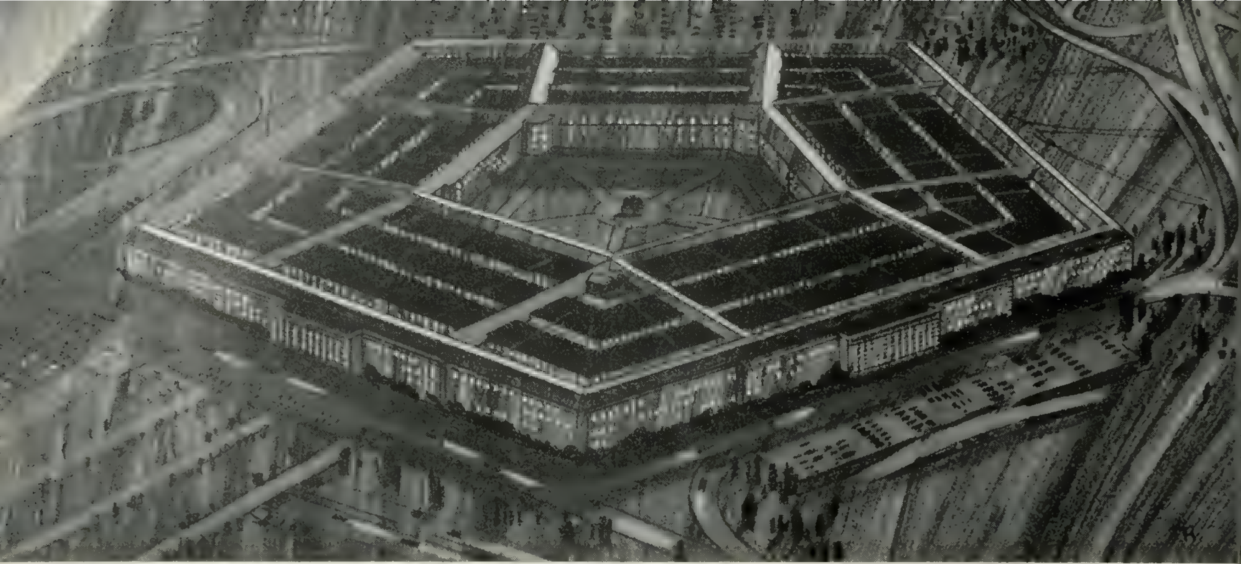
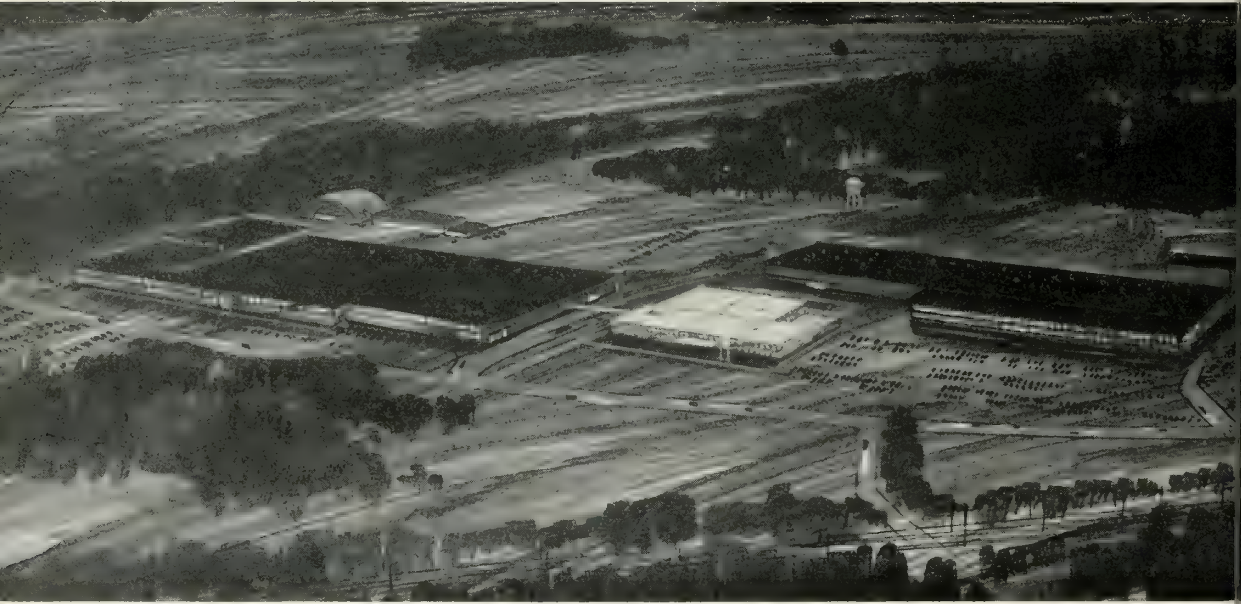


Defense Center



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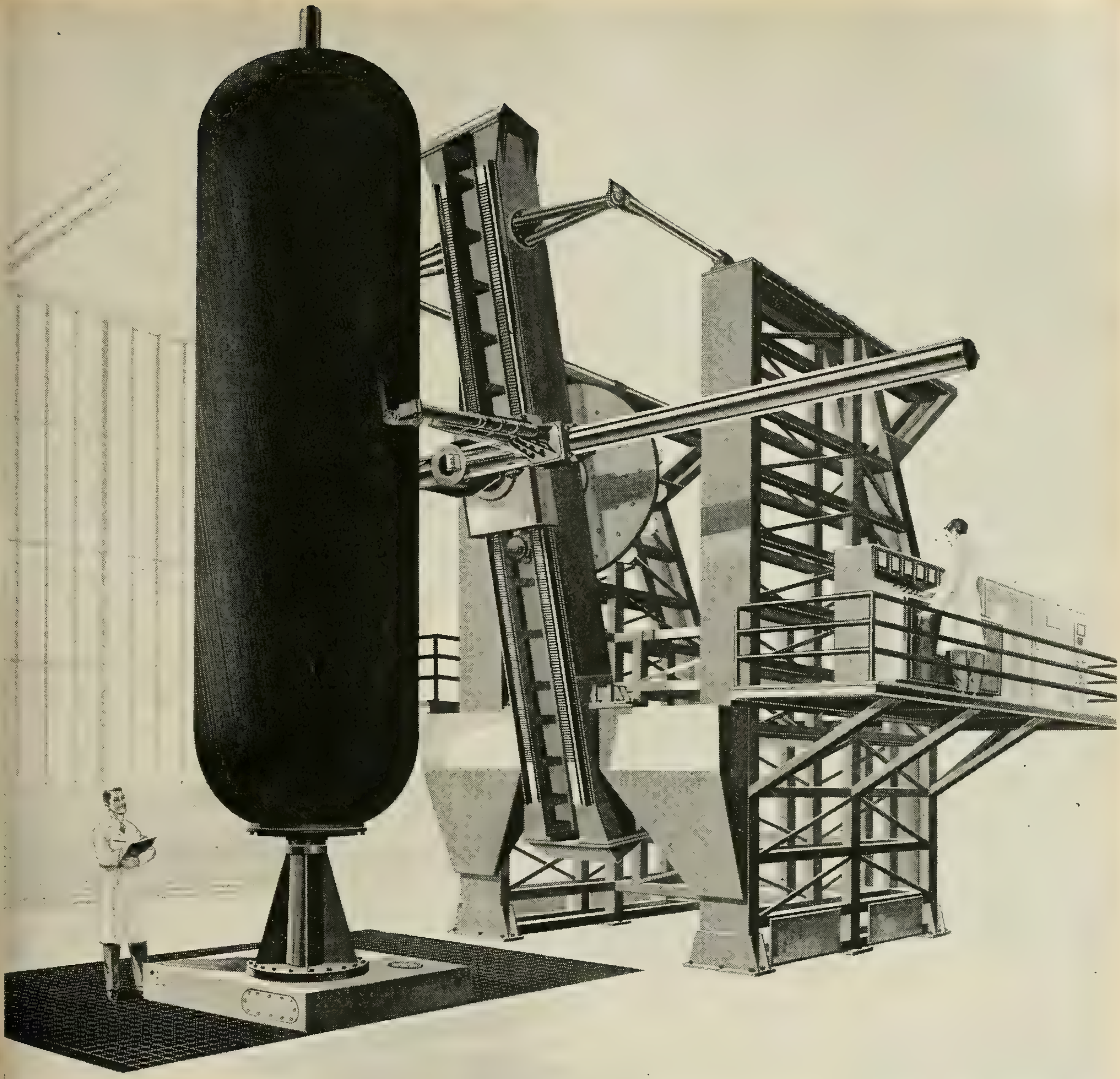

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What is the exact shape of the moon? Interference of the earth's shadow has long prevented man from determining it. To solve this mystery, an "eclipse expedition" from Lockheed's Rye Canyon Research Center recently traveled 10,000 miles to Oudtshoorn, South Africa. They photographed the moon—under ideal scientific conditions—for the 37 seconds it was silhouetted against the sun's near-perfect circle.

The precise measurements secured by this "moon safari" provide added information on the effects of moon gravity: data of great importance in planning lunar landings and computing the lifetime of vehicles which will orbit the moon.

Lunar and planetary studies are but one of the basic projects under research by Lockheed scientists and engineers at

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missiles and rockets

Volume 13, Number 7 August 12, 1963

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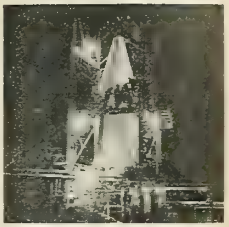

Night-shift engineers and technicians attach insulation panels to Centaur test tank in preparation for liquid hydrogen tests. Work on the Surveyor booster continues around the clock at General Dynamics/Astronautics, San Diego, Calif., to meet 1965 operational mission schedules.

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letters

State of the Union

To the Editor:

Having been a reader and admirer of MISSILES AND ROCKETS for some time, I found myself somewhat disturbed at your "State of the Union" editorial of July 22.

First, If Mr. Steinbeck and his reporter really want "ten white, able-bodied Americans who aren't afraid to have a conviction . . . in an unpopular field," then I am reasonably sure that there are not only ten but thousands of Americans who are still convinced that the strength of this nation is based on moral righteousness and individual integrity—not space. However, I must admit that such an idea seems to be more and more an "unpopular field" of thought.

Secondly, working for a company involved either directly or indirectly with various rocket and missile programs over the last several years, I am aware of the vast amount of knowledge to be gained with the exploration of space, and of the military implications in that area. In addition, long before the first sputnik, I fervently thanked Almighty God for placing the Moon where He did, as a steppingstone to space. No doubt some day it will be used for just that! In addition, my imagination has often been excited by the secrets that await discovery when the Moon, or Mars, or other such places are explored. I go on record as favoring, even personally desiring, the exploration of space, *But not at the expense of other things that also must be done.* As a nation we have a great capacity in many areas, but in spite of our greatness, more cries out to be done than we can do. We should firmly resolve to do the things that *must* be done, even at the expense of things that *ought* to be done. The space program, then, cannot be judged by itself but must be considered as a part of the whole of our national obligations, and frankly, in that light, I cannot honestly place it first.

Thirdly, if one were to attempt to "sell" the space program to me in the same manner as "soap and cigarettes are sold," then the whole effort to convince me would fail. Surely an appeal to the intellect is still the most valid way to present the "case for space." If this program is honestly as important as some feel, then reason should demonstrate that fact.

Lyle K. Porter
Sandia Corporation
Albuquerque, N.M.

To the Editor:

I am generally in agreement with the editorials in M/R, but your July 15 and 22 comments I feel are offbase and illogical. To wit:

A. Why should industry or the country in general be sympathetic with a space program that is not vital to national security (JFK says our NASA program is for peaceful purposes only) and requires huge amounts of money to blast huge, ungainly engines from the Earth. On the first count, let's get a satisfactory military space program adequately funded before going to the Moon "because it's there" or "because the Russians are doing it." On the second count, how does the country know that the *Aerospace Plane* concept might not be best for space exploration—that the whole NASA program will not turn out to be a waste of time and facilities?

B. If all the hoopla and exposure the NASA program has had through *Mercury*, with magazines, TV, etc., literally exploding with news, has not served to put the U.S. into the Space Age, then I cannot help but feel that industry's efforts will be for naught. As for your premise that an informed public will pressure Congress into action, it is more likely that an informed and somewhat disgruntled Congress would start sending committee testimony to its constituents and shock them back to the Stone Age with funding requests and examples of wastage. As for your survey of teenage attitudes, don't be dismayed. I took one recently and showed that 12% of the teens thought that Bobby Kennedy should succeed his brother in the event of the President's death.

C. You're picking on the wrong group to put up their backs and fight for something when you ask the aerospace industry to carry the sword. I can't think of an instance when the industry stood together and said "this is right," or "we believe in this approach." It didn't happen over nuclear-powered aircraft, manned bombers, or even union contracts. Where is the group in industry saying "we think that what the country needs is a whole new arsenal of strategic weapons." Simple, they're trying to sell antitank weapons and defoliants. I'm not blaming anyone, it's just that the aerospace industry knows where the bread comes from and when there's an argument going on about how to apply the butter, no wise contractor is going to open his mouth *until* he spots the clear winner; then, oboy, watch out!

Robert S. Anderson
Levittown, N.J.

To the Editor:

Congratulations on the editorial. The American people must be dragged, "kicking and screaming," into the Space Age if this is the only way they can be gotten there. A massive publicity campaign such as you suggest would be a great help toward this end.

Popular and semitechnical publications would also be a great aid toward helping the public understand the Space Age and its implications. Checking of newsstands and bookstores will reveal a great shortage of this type of publication. There used to be several magazines on the newsstands that were devoted to this type of material (*Space Age, Space World, Space Journal,* and a few "one-shot" publications), but they can no longer be obtained there.

D. W. Johnston
Washington, D.C.

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The Countdown

WASHINGTON

Centaur Slips Again

Launch date for the second *Centaur* flight is now Sept. 29, but officials expect a slip into the first half of October. The new target date itself represents a three-month slippage from the mid-1963 date set when the liquid hydrogen program was revamped earlied this year. It probably will also mean that NASA won't get in a second launch this year. Thus, the current operational target date—late 1964 or early '65—is now highly unlikely.

New Echo Project Studied

NASA is considering a rigidized 450-ft.-dia. *Echo* passive communications satellite. No funds are available for such a program and no decision has been made as to when, if ever, there will be funds. With Project *Rebound* cancelled, the new *Echo* could be the next passive communications satellite program at the space agency.

SBA Redefines Smallness

Small Business Administration has changed the size standards used for qualifying firms as small businesses for government procurement purposes. In subcontracts worth less than $2,500 the number of employees cannot exceed 500. In non-manufacturing areas, the number may not top 500 even if the subcontract is worth more than $2,500. In contracts involving manufacture of missile/space components, the standard usually ranges from 750 to 1,000.

SSD Nears X-20 Takeover

The Air Force is expected very soon to announce officially that its Space Systems Division has been assigned overall test responsibilities for the *X-20 Dyna-Soar* program (COUNTDOWN, July 29, p. 11). SSD has been handling orbital phases of the program, while Aeronautical Systems Division—which initially was in charge of the entire project—worked on air-drop aspects. ASD is not happy about the transfer.

INDUSTRY

Getting Ready for Titan III

Work will begin at Cape Canaveral and Merritt Island this week on nearly $25 million worth of new construction. Biggest item involved is *Titan III* complex: under a $22,480,000 joint contract, Paul Hardeman, Inc., and Morrison-Knudsen, Inc., both of Stanton, Calif., will build a Vertical Integration Building and a Solid Motor Assembly Building—each 23 stories high. Also included is a 30,000-ft. railroad system to transport *Titan* from the Vertical Assembly Building through the Solid Motor Assembly Building to Complexes 40 and 41. Railroad will tie in with an 18-mi. line to be constructed by B. B. McCormick & Son, Inc., of Jacksonville, Fla., under a $2,444,450 award. This will give the Cape its first railroad connection with the mainland.

Union Gains at Cape

Machinists at Cape Canaveral apparently are winning their fight to keep the Air Force from taking over civilian jobs. Labor Dept. had scheduled a hearing on the matter at the Cape this week, but suddenly called it off. Meantime, General Dynamics has called back to work a number of its IAM employees who had been replaced by "blue suits."

Aerojet Wins Mississippi Award

Aerojet-General Corp. has been awarded an $18,254,800 contract for technical systems for the *Saturn V* test site at Mississippi Test Facility. In another MTF development, the Labor Dept. is expected to announce shortly a no-strike agreement covering construction at the site through mid-1965.

Huge Shaker Working at Rocketdyne

A 15-ton shaker table that can vibrate up to 2,000 cycles per second at forces to 30,000 lbs. is being used to test large components of J-2 and F-1 rocket engines at Rocketdyne in Canoga Park, Calif. Additional shaker systems will be installed to eventually permit vibration tests of an entire F-1 engine, which will weigh 16,000 lbs.

Millikan on A-G Board

Dr. Clark B. Millikan, one of the top U.S. aerospace scientists, has been named to the Board of Directors of Aerojet-General Corp. He has long been a member of the company's Technical Advisory Board, and earlier served on several government scientific advisory boards.

INTERNATIONAL

Three-Nation Dazzle Program Planned

The U.S., Britain and Australia have agreed to cooperate in a program to study high-speed re-entry of objects from outer space. Called Project Dazzle, the investigation will employ the British two-stage *Black Knight* booster. The re-entry package, to be designed by the British, will be fired on a ballistic flight from the Woomera range in Australia. It will be fired back down into the atmosphere by the solid second stage of the booster. ARPA will supply instrumentation to be used to observe re-entry, and British and Australian scientists will analyze data. No date has been set for the firing.

Japanese Rockets Interest Weather Bureau

U.S. Weather Bureau officials are considering purchase of Japanese advanced weather observation rockets. The 7½-ft.-long rockets were developed by Prince Motors, Ltd., of Tokyo as a follow-on to the *Kappa* series. Haruhiko Niiyama, vice president of Prince, will visit the U.S. soon to discuss details of the sale.

A RARE

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SYSTEMS

ACTIVITY

The Applied Physics Laboratory, The Johns Hopkins University, has prime responsibility for the operational evaluation of the Polaris weapon system, including navigation, fire control, launcher, missile, and submarine.

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The Missile/Space Week

ComSat Corp. Studies Let

Study contracts—the first awards made by the Communications Satellite Corp.—have been won by American Telephone and Telegraph Co., Hughes Aircraft Co., and Radio Corp. of America.

The three awards, totalling $150,000 and announced Aug. 6, call for the firms to perform studies on multiple access techniques for communication satellites. The studies are to be completed in 90 days.

One problem to be overcome in designing a commercial communications satellite system, the corporation says, is that of providing a method for a number of ground stations to transmit and receive simultaneously through each satellite in the system.

The awards are aimed at providing a solution to this problem.

AT&T will advance its previous studies and work for an approach to permit multiple access without requiring any equipment other than that needed for single paired-access operation. This proposed system would require that ground stations regulate the power output of their transmitters.

RCA will investigate a satellite-borne ferrite limiter aimed at providing multiple access without requiring ground station power control.

Hughes will study application of methods of multiple access to stationary satellites, including testing a 10-kw travelling wave tube designed to provide maximum efficiency when amplifying 600 channels simultaneously in a satellite.

Three other companies submitted proposals on multiple access techniques: General Telephone and Electronics, International Telephone and Telegraph and Philco Corp.

Contractor Directive Issued

The Department of Defense Contractor Performance Evaluation Program has received Secretary McNamara's approval and is spelled out in DOD Directive 5126.38.

As explained by Assistant Secretary of Defense Thomas D. Morris in the keynote speech of the first DOD/National Security Industrial Association Symposium in Washington, the system will provide DOD with a detailed record of past performance by contractors on major development contracts.

The record will contain verified data on actual performance against stated technical objectives, schedules and cost estimates. Morris said the new directive calls for performance evaluation by the DOD project manager every six months during the duration of a program.

Initial reports must be submitted not later than one year after contract award. The reports will be reviewed by the contractor and by performance evaluation groups in the appropriate military departments to ensure accuracy and objectivity. The project manager's terminal report must be certified by an evaluation group through an independent field investigation, continued Morris.

The contractor's comments will become part of the permanent record to be stored in a central data bank. The system will be implemented for every program exceeding $5 million in one year or $20 million through its lifetime.

Now that DOD has approved the program, NASA will probably conduct a test case of the system on one prime contract.

Holmes Joining Raytheon

D. Brainerd Holmes, director of NASA's Office of Manned Space Flight, has been named a senior vice president of Raytheon Co., Lexington, Mass.

Holmes, whose forced resignation from his space agency post followed long disagreements with Administrator James E. Webb, will assume his new job Oct. 1.

Raytheon said the Holmes appointment was a "major move to strengthen the company's management."

Holmes will be succeeded at NASA Sept. 1 by Dr. George Mueller, currently vice president of research and development at Space Technology Laboratories.

Shots of the Week

NASA's Shotput launch vehicle carried a 177.5-lb. test satellite to an altitude of 183 mi. Aug. 2 from Wallops Island, Va., in the second sounding flight of the joint U.S.-Italian San Marcos project.

The suborbital satellite impacted

606 miles downrange in the Atlantic. Payload, launch vehicle and telemetry are said to have performed "as planned."

A third San Marcos launch is scheduled for late this year, and the project is to terminate with a NASA *Scout*-borne scientific satellite being placed in equatorial orbit by the Italians at a later date.

In a related experiment on the same day, a *Nike-Cajun* vehicle was sent aloft to obtain data on Shotput's ambient air density.

Other shots of the week:

- The USSR launched *Cosmos 19* Aug. 6. This latest unmanned Earth satellite has the announced mission of collecting data on such space phenomena as radiation and the Earth's magnetic fields for application to future manned space flights.

Cosmos 19's apogee is 323 mi.; perogee, 168 mi.; period, 92.3 min. Its inclination to the equator is 49 degrees.

- An Air Force *Minuteman* ICBM launched Aug. 5 from Cape Canaveral fell short of its target.
- Sweden successfully launched a U.S. Army *Nike-Cajun* rocket Aug. 2 from Kronogaard in a test to explore the so-called "bright night clouds."

Astronauts in Good Health

All 16 astronauts are in "top physical condition," and none of those who journeyed into space has suffered any ill effects from the flights, despite rumors to the contrary.

This is the opinion of doctors at the Manned Spacecraft Center, Houston. Rumors circulating in Washington and Houston centered around Scott Carpenter and Walter Schirra, claiming their health had been "in a decline" since their three- and six-orbit flights, respectively.

In response to inquiries, NASA said neither Carpenter nor Schirra was in poor health because of the orbital flights, "or for any other reasons."

The rumors did not mention L. Gordon Cooper, whose 22.9-orbit flight presumably was too recent (May 15-16) for him to have suffered any delayed effects.

Saturn S-IV Stage Fired

Some 500 types of data were recorded during a one-minute static test firing of a *Saturn* S-IV stage Aug. 7 at Douglas Aircraft Co.'s Sacramento, Calif., test facility.

The test of the second stage of the fifth *Saturn* flight vehicle was cut short because of "a minor problem." Full duration for the S-IV stage is seven minutes.

After one more static test, the stage will be flown to Cape Canaveral to become part of the first complete *Saturn I*, which will fly this fall.

Mariner Orbits Sun

The *Mariner II* spacecraft, which successfully performed a fly-by of Venus last Dec. 14, completed its first orbit of the Sun Aug. 1.

The spacecraft, launched Aug. 27, 1962, traveled approximately 540,000,000 mi. to complete the first solar orbit.

The current position of *Mariner II* in space is outside the orbit of Earth at a straight line distance of 47,000,000 mi., below the plane of the Earth's orbit and ahead of Earth. Although its projectory towards Venus was inside Earth's orbit, the path of the spacecraft was altered by the gravitational pull of Venus as *Mariner* flew by the planet. The closest approach to Venus was 21,648 mi.

The current velocity of the spacecraft is 54,200 mph relative to the Sun. The velocity figure increases and decreases during the solar orbit to produce a period of 346 days for each orbit. Aphelion, farthest distance from the Sun in the orbit, is 113.8 million mi. It occurred June 18. Perihelion, closest point to the Sun, is 62.5 million mi. and occurred last Dec. 27.

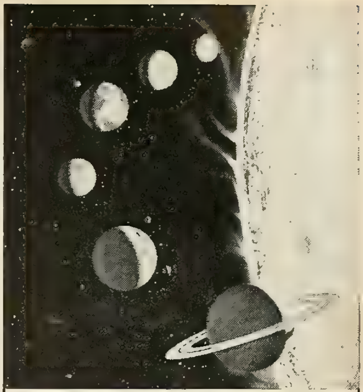
Langley Low Bidder Named

The apparent low bidder for construction of the major building at the Space Radiation Effects Laboratory being developed by the NASA Langley Research Center is Basic Construction Co., Newport News, Va. The company's bid was $3,099,600.

The contract, expected to be awarded within the next 10 days, will complete the major procurement actions involved in the SREL project. It will provide a structure to house the synchrocyclotron and associated equipment, which will form the heart of the new NASA research facility intended to explore the effects of particulate radiation on spacecraft structures and components.

The successful bidder will have 600 calendar days after receipt of notice to complete the job. The Government's estimate of the cost of the laboratory building was $3,100,000.

Second lowest bid was filed by Doyle and Russell, Inc., Norfolk, Va., at $3,211,400.



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Air Force To Take Over PMR

Davis probably will command new AFSC division in charge of ranges; Navy retaining Mugu; White Sands could be affected

by Frank G. McGuire

BONN, GERMANY—Transfer of the Pacific Missile Range from Navy to Air Force hands is expected to be accomplished within six months, informed sources have told MISSILES AND ROCKETS. The transfer, suggested to both services by the Director of Defense Research and Engineering, is described as another move in Dept. of Defense efforts to centralize management, this time in range operations.

The Navy has reportedly registered no strong protest to the transfer because it has no requirement for the full length of the range, and because it will retain the most heavily used portion—offshore from Pt. Mugu to the Channel islands. Pt. Arguello, the launch site for large boosters, is included in the transfer. Pt. Arguello is adjacent to the Strategic Air Command's Vandenberg AFB, and the two probably will be merged.

Range instrumentation ships will continue to be operated by the Navy.

To operate the range, the Air Force is planning to create a new division, under AF Systems Command, which will have overall cognizance of both the Atlantic and Pacific Missile Ranges, as well as the Satellite Test Center.

(One pundit has dubbed the new unit "The Great A&P Range Co.")

The new division, for which Maj. Gen. Leighton I. Davis is likely to be chosen commander, will have three major operating elements: the Atlantic Missile Range, the Pacific Missile Range, and the Satellite Test Center at Sunnyvale.

(Although not discussed in the context of the PMR transfer, Army's White Sands Missile Range is obviously vulnerable to just such a changeover in view of the DOD "centralization" motives in the PMR case.)

The new division will handle range aspects of both missile testing and space-flight operations, coordinating the activities of the globe-circling combination of ranges, but does not as yet have a direct tie-in with the trio of aerospace recovery sites previously chosen. (M/R, June 10, p. 34; July 8, p. 14)

It is understood that the only point left for settlement within the Air Force is the transfer of Vandenberg AFB from SAC to AFSC. As it now stands, SAC is the operator of Vandenberg and AFSC is a tenant thereon for the conduct of satellite and R&D programs. SAC is understood to be reluctant to turn Vandenberg over to AFSC.

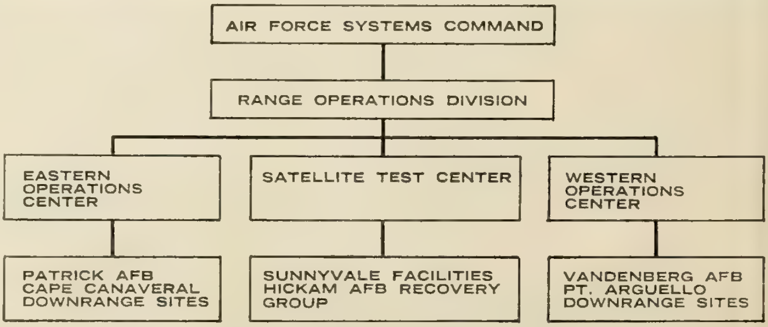
The original concept involving *Titan III* as a heavy-duty space booster called for a launch site at Vandenberg AFB, but lack of funds may have ruled out that portion of the program. Now, with the addition of a made-to-order heavy-duty site at Pt. Arguello, the *Titan III* capabilities may yet be utilized from the West Coast.

- **ARIS deal?**—There is a possibility that a deal was made between Air Force and Navy regarding the future management of the ARIS ships to be used for downrange instrumentation. These ships may be taken over by Navy crews at a later date as a reverse pitch to the same centralized management theme which led to the PMR transfer, inasmuch as the AF has little ship-operating experience. Two ARIS vessels are now in operation.

The Navy is understood to be retaining all or part of the funding budgeted to it for operation of PMR, and may decide to transfer the funds to other programs, or use them for beefing up the Pt. Mugu portion of its existing PMR complex.

- **New organization**—The new AFSC division, for which no official designation has been given, will have an eastern operations center and a western operations center, as well as the Satellite Test Center. The eastern operations center (also not yet officially named) will include management over Patrick AFB, Cape Canaveral Test Annex, and all the downrange sites.

The western operations center will handle what is now Vandenberg AFB, Pt. Arguello launch complex, and all downrange sites. Satellite Test Center, not a part of the western operations center, will maintain its present mission and retain control over the aerial recovery group at Hickam AFB for data capsule retrieval. ■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SATELLITE TEST CENTER
WESTERN OPERATIONS CENTER
PATRICK AFB
CAPE CANAVERAL
DOWNRANGE SITES
SUNNYVALE FACILITIES
HICKAM AFB RECOVERY GROUP
VANDENBERG AFB
PT. ARGUELLO
DOWNRANGE SITES

NOTE: The designations shown on this chart are for functional identification only and do not necessarily reflect official unit designations.

ORGANIZATION of new Air Force ranges division.

M/R Associate Editor Frank G. McGuire has been transferred from his Pentagon post to Geneva, where he is now the magazine's chief European correspondent. Last week he went to Bonn to cover the visit of Defense Secretary McNamara with West German defense officials.

Congress compromises . . .

NASA Authorization Bill Peaking Near $5.36 Billion

by Heather M. David

CONGRESS IS MOVING toward final action on the much-worked-over FY 1964 NASA authorization bill, which is settling around the $5.36-billion level.

A conference committee of House and Senate space committee members will work out a compromise in the $300 million difference in cuts made by the two bodies in the $5.7-billion budget. House leaders have indicated they will press for cutting at least half the difference, in spite of rumors that NASA is confident it will get what it asks from the Senate.

In action last week, the Senate passed its bill authorizing $5.5 billion after the House voted its bill (334 to 57) authorizing only $5.2 billion.

Still to be heard from are the appropriations committees, which can be expected to bring the figure down toward the House level.

- **Senate action**—The Senate passed by a lopsided vote the bill giving the agency back all its manned spacecraft funds and a good portion of other program funds (M/R, July 29, p. 11). Congressman Olin Teague (D-Tex.), chairman of the House Manned Space Flight subcommittee, said he would accept about half the restoration, which would leave NASA with $60 million less than its $1.56-billion request.

M-1 engine funds received favorable treatment from the Senate, which brought the figure up to $30 million. This, the Senate reported, returned the engine to "research development" status. The Senate also indicated its concern for the booster program by supporting the addition of a $2 million fund for chemical propellent research that the House gratuitously added to the NASA budget.

The Senate declined to restore funds for aerospace medicine, but added $15 million to the manned spacecraft integration and checkout budget. It indicated that NASA did a better job of justifying this request before the Senate Committee than before the House. The Senate restored $2 million to the communications satellite program, leaving a total of $44.1 million. The House had approved $42.1 million, after NASA requested $51.1 million.

A $4 million request for follow-on international satellites was restored after being completely wiped out by the House. The Senate report said the restoration came because international negotiations had been consummated after the House hearings.

- **Surveyor Orbiter restored**—One of the largest items the Senate voted to allow NASA was a $28.2 million fund for *Surveyor Orbiter*. While the House cut it completely, NASA is known to have made a strong case for it in Senate hearings. However, the bill is worded so that the money may not be reprogrammed for any other use.

The nuclear rocket program, cut $5 million by the House, was entirely restored because "favorable developments have occurred which make earlier reactor developments apparent."

The Senate supported NASA's network operations item of $80.5 million, which the House set at $77 million, saying that network operations are under contract and cannot be reduced since they are keyed to flight schedules.

The Senate reinstated the full $5 million asked for the Boston Electronics Center, which the House had completely eliminated. It also deleted the requirement made in the House bill that NASA submit a justifying study on the need and nature of the Center, but demanded a study of the location. ■

CONGRESSIONAL ACTION ON NASA '64 BUDGET AUTHORIZATION

	BUDGET REQUEST	HOUSE APPROVED	SENATE APPROVED
RESEARCH AND DEVELOPMENT:			
Manned spacecraft system	$1,556,600,000	$1,436,600,000	$1,556,600,000*
Launch vehicle and propulsion system	1,168,500,000	1,138,500,000	1,153,500,000*
Aerospace medicine	16,700,000	11,000,000	11,000,000
Integration and checkout	153,000,000	125,000,000	140,000,000*
Systems engineering	37,000,000	37,000,000	37,000,000
Meteorological satellites	63,700,000	63,700,000	63,700,000
Communications satellites	51,100,000	42,175,000	44,175,000*
Advanced applications satellites	1,000,000	0	0
Industrial applications	3,500,000	3,500,000	3,500,000
Geophysics and astronomy	194,400,000	190,400,000	194,400,000*
Lunar and planetary exploration	322,600,000	254,400,000	282,600,000*
Bioscience	35,200,000	21,200,000	21,200,000
Launch vehicle development	130,700,000	127,700,000	127,700,000
Facility, training and research grants	55,000,000	30,600,000	50,000,000*
Space vehicle systems	61,962,000	53,462,000	53,462,000
Electronic systems	30,362,000	30,362,000	30,362,000
Human factor systems	18,200,000	13,200,000	13,200,000
Nuclear-electric systems	68,768,000	68,768,000	68,768,000
Nuclear rockets	96,687,000	91,687,000	96,687,000*
Chemical propulsion	22,497,000	24,497,000	24,497,000
Space power	16,524,000	16,524,000	16,524,000
Aeronautics	16,200,000	16,200,000	16,200,000
Tracking and data acquisition	231,500,000	216,700,000	220,200,000*
TOTAL	**4,351,700,000**	**4,013,175,000**	**4,225,275,000***
ADMINISTRATIVE OPERATIONS	**560,300,000**	**508,185,000**	**539,185,000***
CONSTRUCTION OF FACILITIES:			
Ames Research Center	13,076,000	11,044,000	11,044,000
Flight Research Center	4,081,000	0	1,157,000*
Goddard Space Flight Center	20,932,000	17,032,500	20,332,500*
Jet Propulsion Laboratory	7,000,000	2,998,200	2,998,200
Langley Research Center	9,768,000	8,204,700	8,204,700
Launch Operations Center	312,855,000	279,677,000	300,316,000*
Lewis Research Center	25,835,000	18,634,000	18,634,000
Manned Spacecraft Center	37,736,000	35,102,000	35,102,000
Marshall Space Flight Center	38,496,000	28,980,000	28,980,000
Michoud Plant	10,003,000	8,688,000	8,688,000
Mississippi Test Facility	111,690,000	92,696,000	102,196,000*
Nuclear Rocket Development Station	20,490,000	15,650,000	15,650,000
Various locations	176,038,000	148,653,000	168,253,000*
Wallops Station	2,000,000	0	505,000*
Facility planning and design	10,000,000	15,000,000	25,000,000*
TOTAL, CONSTRUCTION OF FACILITIES	**800,000,000**	**682,359,400**	**747,060,400***
GRAND TOTAL	**5,712,000,000**	**5,203,719,400**	**5,511,520,400***

* Represents change by Senate Aeronautical & Space Sciences Committee from House bill.

Late this year . . .

Piggyback Explorers Will Study Radiation

NASA HAS ANNOUNCED plans to launch two *Explorer*-series satellites on a *Scout* vehicle late this year.

The piggyback flight, designed to provide information about how the atmosphere reacts to radiation from space, will be made from the Pacific Missile Range.

The satellites—an *Injun* and an inflatable sphere—will be launched into a polar orbit ranging from 1,860 mi. to 392 mi.

The inflatable sphere will be folded in a cylinder inside the *Injun*. When orbit is achieved, a spring will eject the sphere into space.

NASA's Langley Research Center, Hampton, Va., has awarded a $478,922 contract to the State University of Iowa, Iowa City, to provide the *Injun*, which will contain instruments to record corpuscular radiation streaming from space into Earth's upper atmosphere.

The 12-ft. polka-dot inflatable sphere, designed to measure air density, will be similar to the *Explorer IX* now in orbit. It will be built by the Langley Center.

• **New knowledge**—The launch will mark two firsts:

—It will be the first attempt to measure air densities with a polar-orbiting satellite.

—It will be the first attempt to use *Scout* to place two satellites into orbit at the same time.

The two-part experiment is intended to provide new scientific knowledge of how the Earth atmosphere reacts to radiation from space. It is thought that such radiation tends to heat the upper atmosphere, thereby changing its density and probably causing it to extend farther upward from the Earth.

While the *Injun-Explorer* is measuring the downflow of corpuscular radiation into the atmosphere, the measurements of the air density-*Explorer's* orbit will simultaneously indicate drag characteristics in the atmosphere.

Scientists hope that correlating the two sets of data will provide a better understanding of how radiation affects Earth's blanket of air.

A near-polar orbit was chosen to expose both spacecraft to areas of maximum radiation flux. Earth's magnetic field deflects particle radiation in a way that allows it to penetrate more deeply in the polar regions.

Both satellite experiments and the *Scout* are projects of NASA's Office of Space Sciences. Langley Research Center is project manager.

• **Earth satellite meeting**—The space agency also announced that 13 key NASA scientists and engineers will meet this week to discuss the results of five years of research with artificial space satellites, future research plans, and the implications of space research for mankind.

The meeting Aug. 12-16 at Virginia Polytechnic Institute, Blacksburg, Va., is being sponsored by VPI in cooperation with the National Science Foundation and the Langley Research Center.

The conference has a two-fold purpose: to assist in interchange of information among scientists and engineers actively working in space research, and to bring information to stimulate scientists and engineers—particularly in educational institutions—who are not now engaged in space research.

Army Centralizes Guidance R&D Functions at Redstone

ARMY-WIDE research and development of inertial guidance and navigation has been centralized at the Army Inertial Guidance Management Technology Center at Redstone Arsenal, Ala.

The purpose of the center is to coordinate all Army research and development programs in the areas of inertial guidance, navigation, stabilization and control, and to assist other Army agencies in the management and technical aspects of the program.

• **Coordination**—Plans are for the center to participate with other commands in establishing the initial technical requirements for future programs, preparing the requests for proposals and to assist in evaluating the proposals and selecting the contracts.

The center will also assist in preparing the technical development plans and furnish later assistance during the program-definition phase.

Interchange between the various Army specialists on inertial guidance and navigation will be through a technical panel that will meet quarterly to review the status of current programs, discuss problem areas, assess the state of the art, establish future programs and requirements and attack the problem of inertial testing techniques and performance specifications.

The first meeting of the technical panel was conducted recently at the Army Missile Command under the chairmanship of William V. Gudaitis, deputy director of the Inertial Guidance and Control Laboratory.

The center is also responsible for establishing a management and technology file on inertial systems and components. Work has started on an automatic retrieval system for this data. Once the system is available, an engineer at the center will be able to obtain all information on programs, systems, or components at the push of a button or the insertion of a punched card into data-processing equipment.

In addition, the center is designed as the principal contact point for industry or other government agencies seeking information on current programs or future requirements. The center in turn will coordinate with similar centers established by the Air Force, Navy, NASA, and the Federal Aviation Agency.

Other specialized facilities proposed as the result of the new assignment include an electric sled capable of testing inertial components and systems under accurately controlled linear acceleration forces from 0 to 200 g's, and a digital-analog simulation facility that can be used to study and run performance tests on new inertial systems and components.

Apollo role possible . . .

Lockheed Marketing New T/M System

HIGH FORMAT utilization and broad output capability are inherent characteristics of a new pulse code modulation telemetry system now available from Lockheed Electronics Co.

First revealed at the National Telemetering Conference at Albuquerque, N.M., last May, the new system recently completed its life and environmental testing successfully, and will soon be marketed.

The Model PCM/101 employs a magnetic core memory for programming to bypass the problems generated by more conventional patchboard or switching systems to attain format control.

- **Washington showing**—Shown at last week's International Aerospace Support Conference in Washington, the new system employs a paper tape reader to simplify format loading into the memory.

Both NASA and Air Force procurement offices have shown interest in the system. First purchase, for *Apollo* support, is expected imminently by Lockheed.

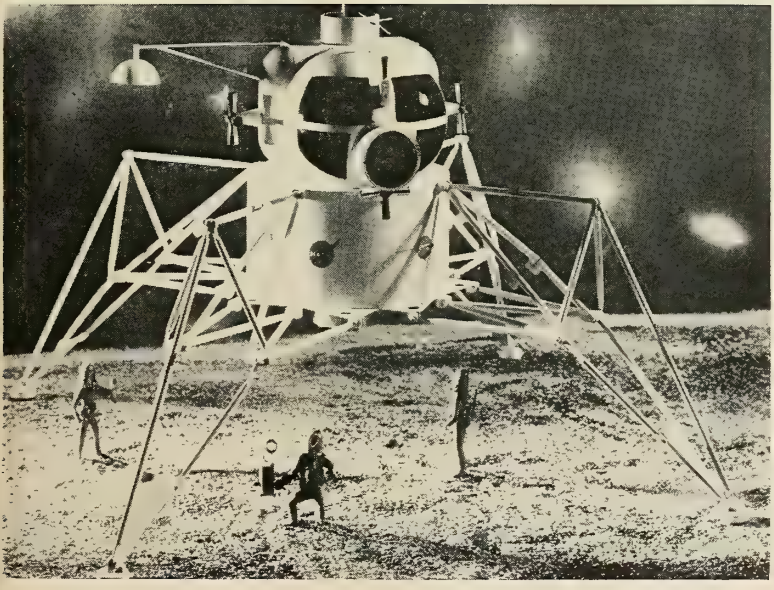
The system, according to developers, will accept PCM inputs from any source. It employs a signal conditioner that generates a precise series of clock pulses synchronized with the incoming bit frequency. It also detects and reads data bits and regenerates a PCM data train converted to NRZ(L) code.

The digital processing section of the system is comprised of a serial-to-parallel converter, secondary synchronizers, control circuitry and the output register. All data channels appear as parallel binary outputs; channel addresses are provided simultaneously in BCD. The output also includes other normal functions such as continued word and parity.

- **Operation**—The system operates from an input of 0.5 to 120 v peak over a 15-db dynamic range. It will accept from 5 to 2,000,000 bits/sec (NRZ) or 3 to 1,000,000 bits/sec (RZ/Split Phase).

For decommutation, the system will handle words and syllables from 1 to 64 bits in length. Bit rate is up to 2,000,000 bits/sec.

The multi-program storage unit is capable of up to 4,096 words of which 3,840 are available for channel and sub-channel addresses. Up to four large PCM formats can be stored, and the 3,840 memory word positions can be divided among these in any way. Manual, automatic or remote format switching is available. Bit rates can be switched with format, according to LEC. ■



LEM Model Aids Landing Gear Development

THIS 1/20 SCALE model of the Lunar Excursion Module (LEM) is being used by Bendix Corp. engineers in a program to develop landing legs for the lunar craft. Development is taking place at the firm's Products Aerospace Div. in South Bend, Ind. Full-scale LEM will weigh 25,000 lbs. Landing leg design of Grumman Aircraft Engineering Corp. (LEM prime contractor) calls for four legs, each with a 3-ft.-dia. bearing pad at the foot, with a crushable structure on the bottom to dissipate energy.

IAS Conference Turnout Disappointing

Attendance at last week's 5-day International Aerospace Support Conference and Exhibition in Washington was far below expectations. Over 70 exhibits drew limited response from the attendees and the 40-odd technical sessions were poorly supported.

Early attendance predictions, based on an unusually good advance registration of over 800, were approximately 4,000. But by Aug 7, previously optimistic conference officials were hoping for a total registration of 1,500.

Industry experts were hard put to explain the poor showing. The conference, on the surface, had everything in its favor: it was sponsored by the very large Institute of Electrical and Electronics Engineers, it was well organized and publicized for nearly a year, and it encompassed a field that accounts for well over one fourth of all the current missile/space dollar expenditures.

The question pondered by all was if this potentially major technical event foreshadowed a general decline in support during the next year at similar national aerospace functions.

For LEM training . . .

Bell Aerosystems Alters LLRV Design to Better Performance

by Michael Getler

BUFFALO—Design of the Lunar Landing Research Vehicle (LLRV), now being built at Textron's Bell Aerosystems Co. here, has been altered to cut vehicle size and weight while more closely duplicating the pilot location in LEM (Lunar Excursion Module).

Bell is building two of these highly flexible research vehicles for NASA's Flight Research Center at Edwards AFB, Calif., under a $3.7-million contract from Manned Spacecraft Center.

Because of their unique ability to simulate lunar flight conditions, the vehicles should make it possible to extensively test and develop lunar landing techniques and pilot procedures in an Earth environment early in NASA's *Apollo* lunar landing program.

Bell reports that LLRV engineering effort is virtually complete, and parts fabrication for both vehicles is under way. The first LLRV is expected to be completed in January, 1964, with delivery to Edwards in April. Flight testing should start about a month after delivery. The second unit should follow in about two months.

Availability of a vehicle of this sort—roughly two years before actual piloted in-flight research will begin with LEM test vehicles—is expected to have a major impact on planning for the LEM mission.

A major change, which has altered both the appearance and performance of LLRV, is shifting the cockpit from on top of the major engine lifting stage to a position in front of the engine. To physically balance this, much of the electronics equipment, some rocket components, and research instrumentation have been mounted and extended, in boom fashion, beyond the engine (see illustration).

With this new configuration, Bell engineers report they have cut LLRV height from 15 ft. to 10 ft., shaved off a "couple hundred lbs." from the original 3,400-lb. weight, and put the pilot in a position much more similar to that he will occupy in LEM.

- **Design motivation**—Kenneth L. Levin, technical director of the project at Bell, told MISSILES AND ROCKETS that one main objective of LLRV design was to come up with a basically simple vehicle using readily available components. Rather than attempting to optimize the design of everything, Bell has planned LLRV to give the "feel" for LEM rather than to duplicate it physically. Virtually everything on the vehicle is removable, and many of the operating systems can be easily retrofitted with actual LEM hardware when it becomes available.

The LLRV airframe uses standard welded aluminum tubing in truss construction, with the landing legs bolted—rather than welded—to facilitate easy removal and tests with other gear configurations. Current design uses standard aircraft-type shock struts with a 7-in.-dia. rubber foot on each of the four legs.

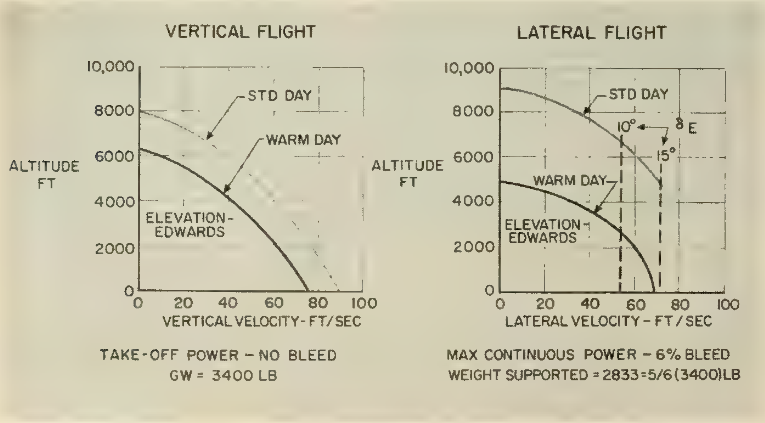
LLRV has three basic propulsion systems which combine to form a capability for lunar simulation and independent test operation.

Vertically mounted within a two-axis gimbal ring in the airframe is the main propulsion unit, a General Electric Co. CF-700 aft fan turbo jet engine which develops 4,200 lbs. of sea-level static thrust. It's reported that the engine is now undergoing successful test runs at GE's Lynn, Mass., plant.

The engine's range of throttle settings is such that at full power it is used to lift the vehicle from the ground and fly it to altitude prior to a simulated lunar letdown maneuver. At a reduced power setting, it serves to counteract ⅚ of Earth's gravity; the remaining ⅙, which duplicates lunar gravity, has to be contended with by the associated lunar thrust rocket system.

Because it must counteract most of the Earth's gravity, the engine is designed so that the thrust vector passes through the vehicle's center of gravity (cg). The engine is gyro-stabilized to an Earth vertical and is unaffected by vehicle attitude. To prevent cg shifts due to propellant consumption, tanks are located in the cg plane.

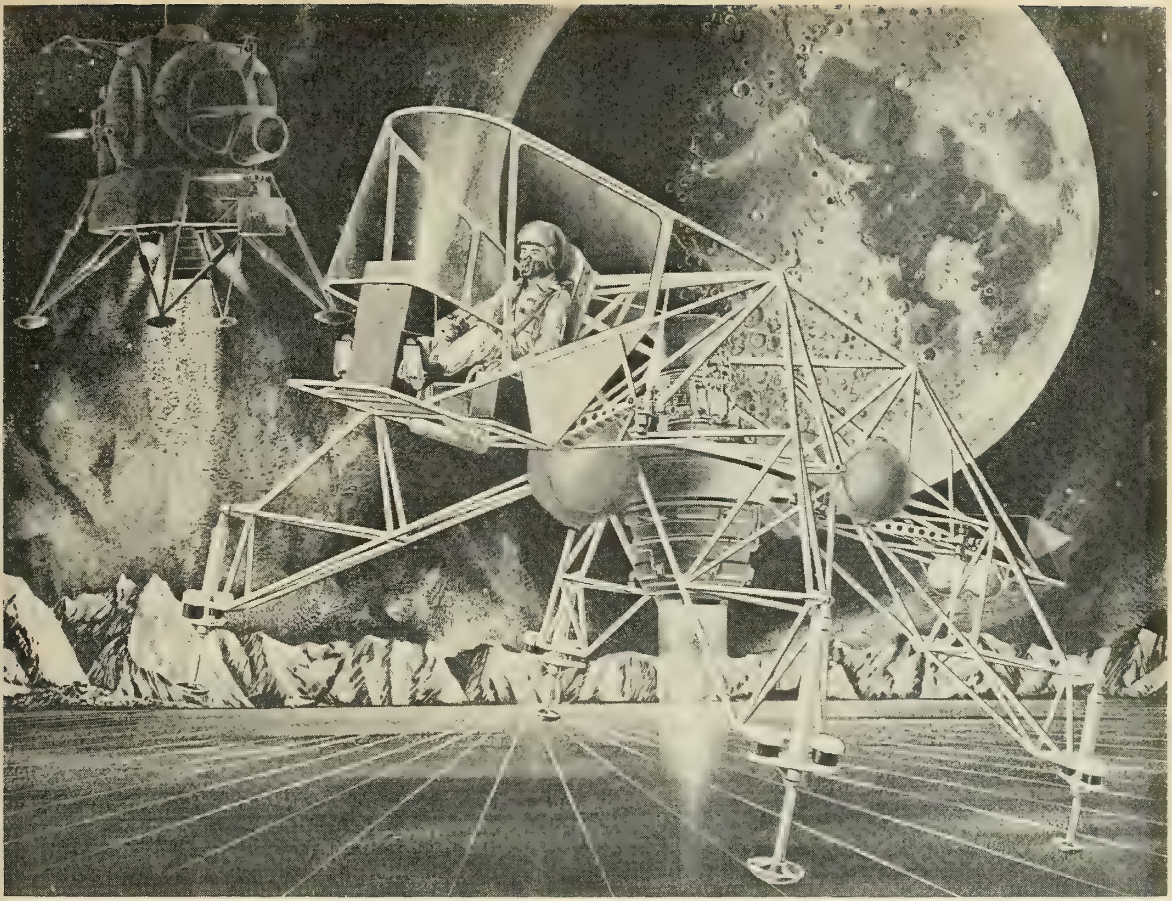
Bell says the vehicle has been designed to provide 40-deg angular freedom in pitch and roll between the jet engine and the vehicle, allowing tilt of the vehicle to simulate longitudinal or lateral acceleration, and also to allow independent tilt of the engine to counter-



TAKE-OFF POWER – NO BLEED
GW = 3400 LB

MAX CONTINUOUS POWER – 6% BLEED
WEIGHT SUPPORTED = 2833=5/6(3400)LB

LLRV envelope for 200 lbs. of instruments, 10 min. jet fuel, 2 min. rocket fuel.



ARTIST'S CONCEPT of Bell's Lunar Landing Research Vehicle shows new configuration with cockpit forward of fan jet engine, rather than on top of it. Equipment mounted in the rear provides a physical balance for the vehicle.

act atmospheric drag on the vehicle.

- **Drag compensation**—While the engine thrust is automatically controlled (there is also a manual overide) to provide the lunar gravity simulation, the system compensating for the Earth's atmospheric drag injects the simulated lunar vacuum conditions into the flight profile.

Accelerometer measurements of the atmospheric drag are fed through an on-board analog system into the engine control loop. They tilt the jet engine to compensate for rates up to 60 fps in horizontal flight and for vertical drag to 100 fps.

Actual support of the vehicle in the ⅙-Earth lunar environment is provided by a throttleable hydrogen-peroxide lift rocket system operated under pilot control. Two of these devices are sufficient for the landing task, but LLRV design includes eight units, ringing the jet engine, which could effectively land the vehicle if the jet engine failed.

The third propulsion component is the highly redundant hydrogen-peroxide attitude control system. Sixteen of these rockets (4 pitch, 4 roll, and 8 yaw) comprise two complete systems, pilot-controlled with a conventional stick-and-rudder-pedal cockpit arrangement. The attitude system, engineered with the same design logic used in LEM, is very similar to the *X-15* and *Mercury* systems developed by Bell.

Propellant needs are handled by four fuel tanks, two for the JP-4 jet engine fuel and two for the hydrogen-peroxide.

- **Flight capabilities**— LLRV will be capable of flying on the jet engine alone for about 10 minutes. It will carry a rocket fuel load which allows for landing maneuver of about two minutes' duration, with touchdown velocities equivalent to the expected LEM figures (M/R, July 15, p. 23).

It will be able to climb under its own power to a point roughly 4,000 ft. above the Edwards site. It will have a maximum vertical velocity of 90 fps and a maximum lateral velocity of 70 fps. Duration and velocity give the LLRV about a 3-mile area for descent, translation, hover, and landing.

Bell says the fuel tanks are designed so that flight time can be increased by about 50%, if more flight duration is needed at the expense of other payload considerations.

The LLRV cockpit is a plexiglass enclosure, open at the top and fitted with a zero-velocity, zero-altitude ejection seat. The delivered vehicles will be fitted for single-pilot operation, but Bell says the cockpit can easily be modified to handle a second seat, as in LEM. Portions of the cockpit can be blocked off to simulate LEM window configurations.

The cockpit is designed so that the pilot can control vehicle speeds, rates, and attitudes. A variable-stability autopilot is also included to simulate the wide variations in apparent speed of response and damping characteristics.

Levin says three Bell test pilots and NASA's Joseph A. Walker all have flown Bell's LLRV ground-based analog simulator without difficulty and have reported that the simulation presented a "different feel" from Earth-type vehicles. He adds that the same reaction was expressed by engineers who took part in simulations run at Grumman Aircraft Engineering Corp., LEM prime. ■

Technical Countdown

ADVANCED MATERIALS

Superconductivity Goes Commercial

The first practical superconducting material aimed at fabricating high-field (100 kilogauss) magnets is in commercial production at National Research Corp. The Norton Co. subsidiary kept the development under wraps for three years. Company spokesmen say the material, coupled with the production ability, will take superconductivity out of the experimental and demonstration category and make it a working tool within the reach of small organizations. The niobium stannide material has an ultimate field estimated to be above 250,000 gauss. The NRC superconductor consists of an ultra-thin coating of niobium stannide on niobium ribbon. The layered material has been bent around a ⅜-in. radius with no performance loss, and its critical temperature is 18° K. The layer can carry more than a million amps/cm^2 without a magnetic field, and current densities of about 200,000 amps/cm^2 can be reached in a 100 kilogauss field. Initial lots are available in the form of 1/16-in. ribbon costing 50 cents/ft. and ⅛-in. wide ribbon at $1.00/ft. Performance tests were carried out by the Massachusetts Institute of Technology Magnet Lab, Lawrence Radiation Labs and NASA's Lewis Research Center.

Non-Metallic Structural Test System Developed

A complete system for automatically testing the structural soundness, resin-to-glass ratios and inner wall thicknesses of the *Polaris A3* motor chambers is being installed at Aerojet-General's Sacramento plant. Designed and built by Magnaflux Corp. with the cooperation of Aerojet, the device uses corona, eddy current, beta ray and Microwave systems on one rig channelled through a common console. A two-man crew can check out a *Polaris* motor case in less than eight hours with the CEBM system. W. E. Thomas, Magnaflux president, says the system will be marketed for any other suitable non-metallic test application.

ELECTRONICS

Two Apollo APU's Shown

Powercel 3A and 6A, hydrogen-oxygen fuel cells now undergoing environmental testing for NASA's *Apollo* manned spacecraft, were exhibited for the first time publicly at last week's International Aerospace Support Conference in Washington. Under development for North American Aviation, *Apollo* prime contractor, the 2-kw, 250-lb. Model 3A is designed to operate at a 70% thermal efficiency with an estimated MTBF of 2,000 hrs. Three flight units will provide primary electrical power for the command and service modules—two in operation plus one standby. The complete system, excluding tankage and the glycol closed-cycle radiator system (being built by NAA) will weigh about 1,500 lbs. The first unit delivery to NAA is expected in one year. The smaller (900-watt) Pratt & Whitney system, Powercel 6A, is being developed for the Lunar Excursion Module under subcontract to Grumman, LEM prime.

Electronics Outlook Up in West

Electronic manufacturing firms in the West are optimistic about the third quarter business outlook, according to a survey by Western Electronic Manufacturers Assn. After more cautious forecasts earlier in the year, 72% of the companies surveyed now predict third quarter increases in order bookings over the same period a year ago, while 21% look for a decline. The remaining 7% expect no significant change. The survey indicated order bookings during the first quarter of the year were down from 1962 in 36% of the firms, while 60% reported significant gains.

Ultra-high Resolution Radar Developed

Cornell Aeronautical Laboratory engineers have come up with a new FM/CW radar system capable of extremely detailed measurement of radar cross-section characteristics of re-entry bodies. The broadband, linearly-swept system operates in the 1°-gc frequency range with a 40% bandwidth. Called Delta, this system is capable of 2 to 3-in. range resolution, CAL says, and has a compression ratio of about 10,000/1—a value they claim is not realized in any other equipment.

Zeus Data Processor To Be Installed

First production prototype of the *Nike-Zeus* signal data processor is now going in at Kwajalein Island in the Pacific. The unique digital system uses delay-line storage techniques to aid in multiple target-detection and decoy sorting.

Another Approach to Plasma RF Wall

Using a pulsed laser beam, Cornell University scientists have obtained a very dense burst of electrons from the surface of a tungsten cathode. Asst. Prof. Lee MacKenzie, project director, claims that by heating tungsten with a pulsed laser beam, 10,000 or more amperes/cm^2 were obtained compared with 1 to 10 amperes obtained from conventionally heated cathodes. Thus, he pointed out, sufficient energy can be developed to push radio signals through the plasma sheath of a re-entering space vehicle. High-frequency radio tubes, using the Cornell technique, would produce high power at 100 to 200 gc, compared with a present upper limit of 100 gc.

OPTICS

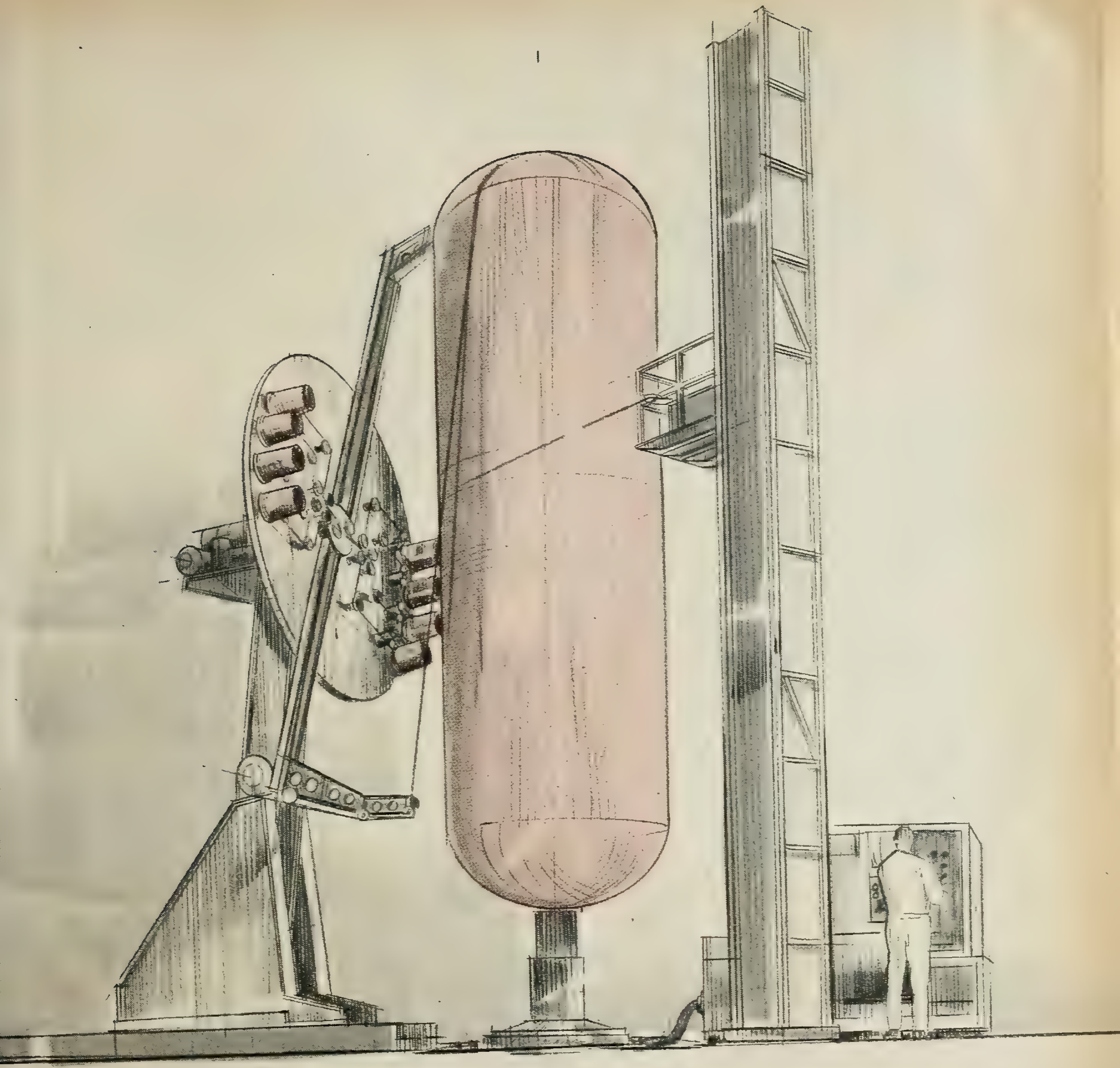
Improved IR Lens Revealed

An infrared lens with a rating of f/0.75 has been developed at Westinghouse Research Laboratories. Previously, IR lenses have had typical ratings of f/1.5, Westinghouse pointed out. Thus the new lens has twice the light-gathering capacity of previous ones. Designed for the 8-12 micron wavelength range, the lens consists of a three-element assembly. The two outer lenses are germanium, the inner is made of IRtran-2. The lens structure, optimized by means of a computer program developed at MIT, is essentially diffraction-limited over a 12-degree field of view, developers declared.

SPACE MEDICINE

Apollo Sled Tests Completed

A series of 48 manned sled runs to record pilot reaction to the various deceleration forces that might be experienced by *Apollo* astronauts during recovery has been completed by the 6571st Aeromedical Research Laboratory, Holloman AFB, N. M. Forty subjects experienced deceleration forces in various seat positions determined according to simulated *Apollo* handling profiles. Maximum force recorded on a subject was 60g. Sleds were fired along the 240-ft. Daisy Decelerator, a compressed-air-driven, dual-rail track with a water braking system.



ONE OF THREE proposed winding machines at Thiokol Chemical Corp.

special report:
FILAMENT WINDING

special report:
FILAMENT WINDING

Plastic Fabrication Technique Seeks Greater Share of Market

FILAMENT WINDING—the art of tailoring materials to complex stress situations through continuous glass filaments and organic binders—spreads through the missile/space industry.

Yet its share of the market is limited to two weapon systems (*Polaris A3* and *Minuteman*) and a handful of special applications.

The basic reason for industrial involvement is in the potential of such a fabrication technique. Filament winding is one of the few known methods of tailor-making an engineering material while producing the structure.

The process is essentially simple—laying continous filaments of reinforcement over a mandrel while applying a binder, then curing the entire resultant structure—but it provides a means of orienting the strength of the composite toward the expected structural stresses.

The major reinforcement used is glass, and the major resin systems are epoxies. The primary application has been in solid-rocket motor cases, where the weight saving results in more range per pound of thrust.

• **Too many cooks?**—The very reasons that make filament winding attractive contribute greatly to its current status, with the ever-present danger that over-enthusiasm could eliminate the technique from any major program of the future.

The capital outlay to build and tool a filament winding facility is significantly low compared to that for a metalworking installation. The manufacturing costs are also much lower, although quality control procedures and a lack of standardized test methods help to bring this figure up appreciably.

The lead time in glass-reinforced cases can fall anywhere between 50% and 60% of that of a comparable metal unit—a major consideration in the rapidly changing propulsion field.

Almost every major aerospace prime and first level subcontracting firm is actively engaged in adapting the process to its needs and market areas. In addition, there are a number of firms whose sole business is filament winding.

Yet the technology is relatively new, and extensive research now in progress across the country may soon solve its one major drawback—its low stiffness or modulus.

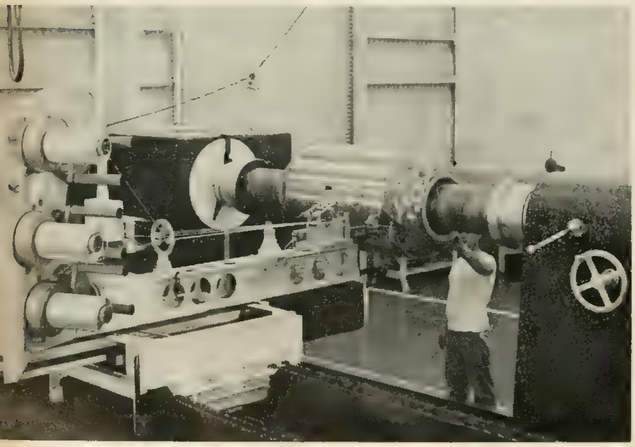
This one factor has kept it out of a major portion of the *Minuteman* program. Glass in lightweight filament-wound structures, has a high compliance—it acts like a whip. Such a characteristic in just the wrong area of a long missile can make the control system ineffective.

There are compromise solutions to this—such as going to greater thicknesses, shortening the stage or pressurizing the stage. Filament winding advocates claim this could also be eliminated in the original design of the entire propulsion system—rather than asking glass to assume the design responsibilities of a metal.

The other major route to reducing compliance is in the development of glass compositions with high modulus while retaining most, if not all, of the high tensile strength. Such compositions are under evaluation and so is the process adaption. Greater stiffness in the original filament will cause process changes in structural fabrication.

• **Dollar Considerations**—Cost and economics can be two different things in filament winding—a glass structure may be far more economical than metal, yet cost as much or more. The problem lies in the end use. If the aim is to significantly increase the range of a weapon system, this ultimate purpose may easily result in an expensive glass motor chamber.

LEFT TO RIGHT: Rohr's numerically controlled winder; impregnating at U. S. Pol



If the goal is to achieve the highest strength possible, costs again may rise. But in both instances, it is more economical to move toward glass instead of metal.

Yet in a careful development program, adequately funded and not done on a crash basis, significant cost savings are possible while retaining the greater part of the inherent advantages of a glass pressure vessel.

For instance, cost analysis at one major propulsion firm indicates a 30% weight savings and a 50% cut in costs by winding the case for a 156-in. dia. motor instead of rolling, welding and heat-treating a state-of-the-art steel.

In another instance, a dry run at the development of large, filament-wound structures with minimum cost in mind pointed to a number of areas within the process where careful scrutiny could cut expenses. The problem here is the same facing all winding enthusiasts—there is a minimum amount of production confidence in the technique, especially in untried sizes and shapes.

But the very same firms that include steel cases in their solid-motor development program proposals are investing capital in filament winding, its equipment, the materials and the techniques.

In a careful but determined effort to keep filament winding abreast of the latest developments in large solids, the Air Force is sponsoring a program to fabricate four large glass motor cases.

Two of these, each 260-in. in diameter, are under contract to Aerojet-General from the Air Force Materials Laboratory, Aeronautical Systems Division, Wright-Patterson AFB. The same organization also gave Thiokol Chemical Corp. the task of constructing two 156-in. segmented glass cases. B.F. Goodrich is winding these under contract to Thiokol (see p. 31.)

Air Force involvement in such large glass motor cases is spurred by the belief that the technology of filament winding is not yet fully developed. Most of the industry agrees—vociferously if not by example.

- **Monolithic approach**—Aerojet plans to wind two subscale chambers, 11 ft. long and 54 in. across, as a preliminary step toward winding the full-scale 260-in. case. The smaller pressure vessels will be wound on existing machinery to verify the design and material choices.

The huge case will be fabricated at Todd Shipyards Corp. on an Aerojet-designed horizontal machine. The massive aluminum mandrel will rotate in a large pit while glass roving is applied via a track running completely around the longitudinal axis of the cylinder.

Two chambers will be built—one scheduled for hydrotesting to burst and the other proof-tested to design pressures. The second case may be loaded and fired in the future, but this is not an integral part of the current contract and no funds have been allocated for a firing. Program completion is scheduled for late 1964.

Aerojet has production experience with filament winding on the *Polaris* program and the results of this plus the many research programs involved are focused on a design optimization study being conducted under Air Force funding.

The program has been expanded to include research to advance filament-wound structures on the basis of the improved mechanical properties of the newer glass fibers.

- **Basic glass**—A 2,000-sq.-ft. laboratory under the direction of Dr. Sam Brelant has been equipped with glass-making, fiberizing and testing equipment. This includes areas for batch formulating and mixing, laboratory-sized furnaces for obtaining experimental quantities of glass, two single orifice fiberizing furnaces, (one enclosed for control of atmospheric conditions), and a 204-hole fiberizing furnace for single end roving.

In addition, take-up equipment capable of drawing glass fibers at speeds up to 12,000 fpm. is available, along with creel and waywinder for experiments with 20-end roving.

While the large case project is not the first involvement by the Air Force in filament winding, the Navy has long been pushing the state-of-the-art, especially through its *Polaris* programs. Now there is a heightened interest in glass-reinforced deep submersibles. This reverses the pressure problem and moves into the relatively unknown area of thick-walled vessels, and research projects are under active funding by the Navy.

Industry has demonstrated confidence in the process. United Technology Center has built and fired small segmented glass-wound motors. The latest monolithic unit is a lightweight, filament wound retro-rocket unit weighing only five lbs. empty. The motor, loaded with 200 lbs. of solid propellant, is designed to deliver 2,300 lbs. thrust for nearly 30 seconds.

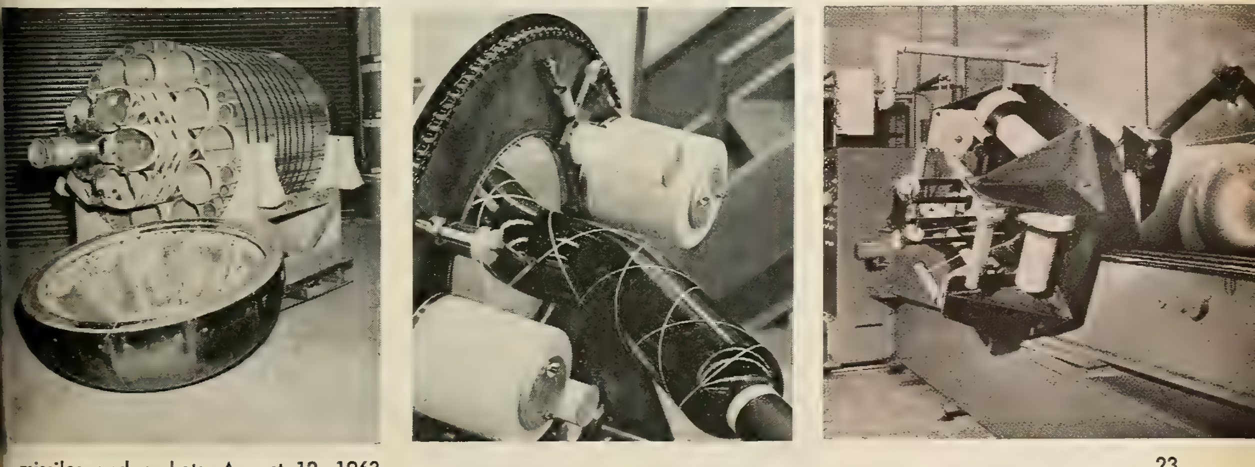
UTC split its glass work down the middle—some aimed at extremely high-mass-ratio upper-stage motors and the other at the massive first-stage booster cases. In the latter area, UTC wound a 156-in. segment incorporating its joint design. But the United Aircraft Division's big winding plans will probably be shelved until the Air Force large-case program is near completion.

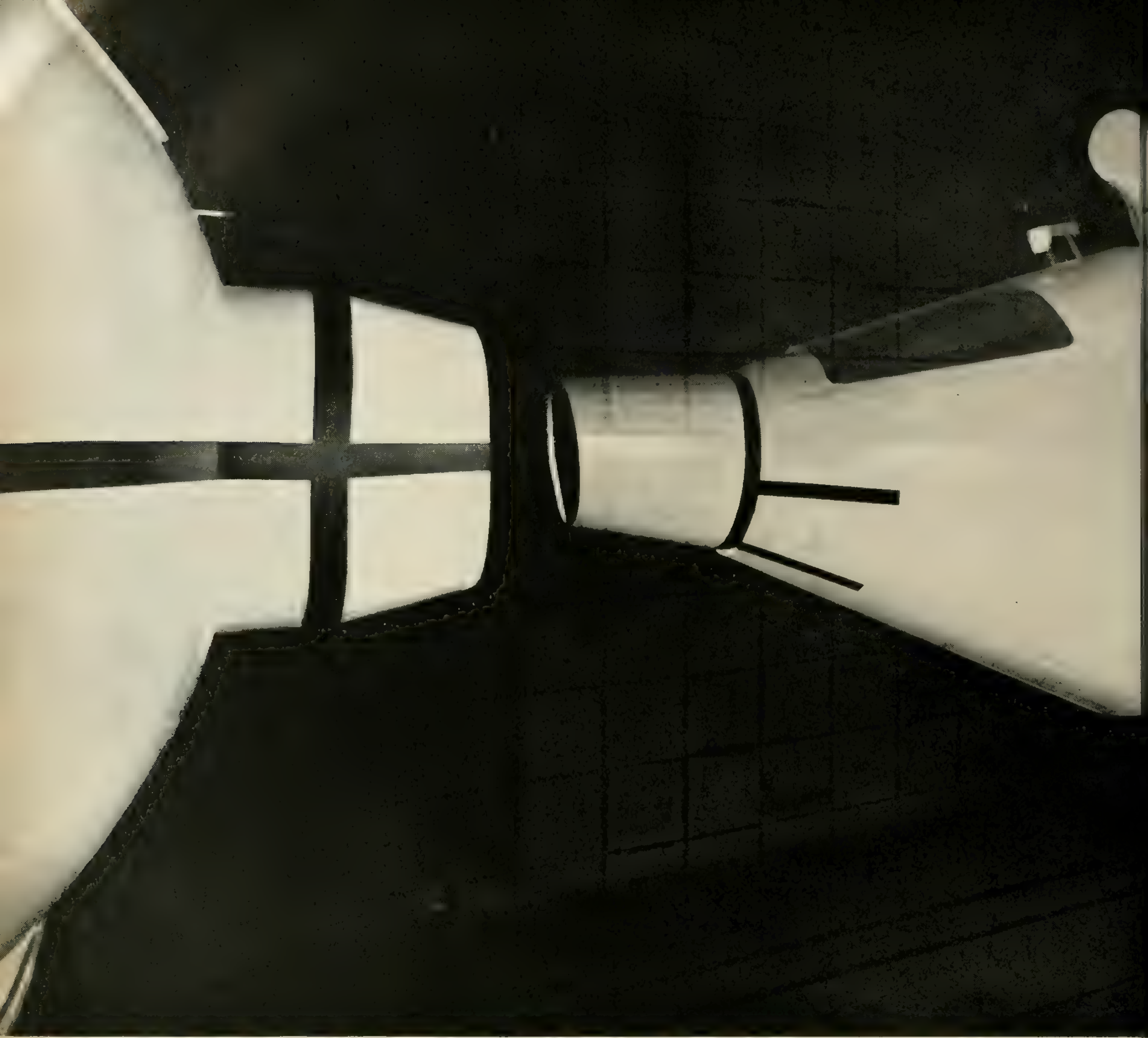
Hercules Powder Co., one of the earliest and largest filament winders in the rocket business, also demonstrated its confidence by fabricating a monolithic 13-ft. diameter prototype case at its Rocky Hill, N. J. plant. (M/R, June 25, 1962, p. 31).

Thiokol Chemical Corp. has long been researching filament-winding techniques both in-house and through sub-

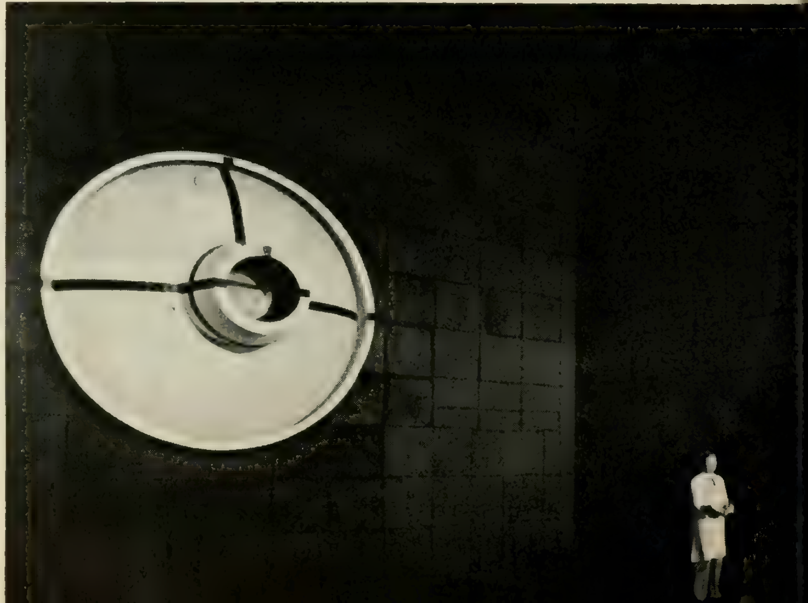
(continued on p. 26)

ol's composite mandrel; tube winding at Rohr; Thiokol's experimental winder.





Triple exposure photograph in new Martin Rendezvous Laboratory shows spacecraft making approac



New 100-foot-long laboratory simulates complete closing and docking for both manned and unmanned missions. Visual and television surveillance can be used during manual operation, radar and laser sensors in fully automatic exercises.

A bank of analog computers supplies effects of space to the mobile module. All room walls are anechoic to free sensors of interfering noise.

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and closure for docking under simulated space conditions.

MANNED RENDEZVOUS:

New Rendezvous Laboratory at Martin investigates closure and docking techniques

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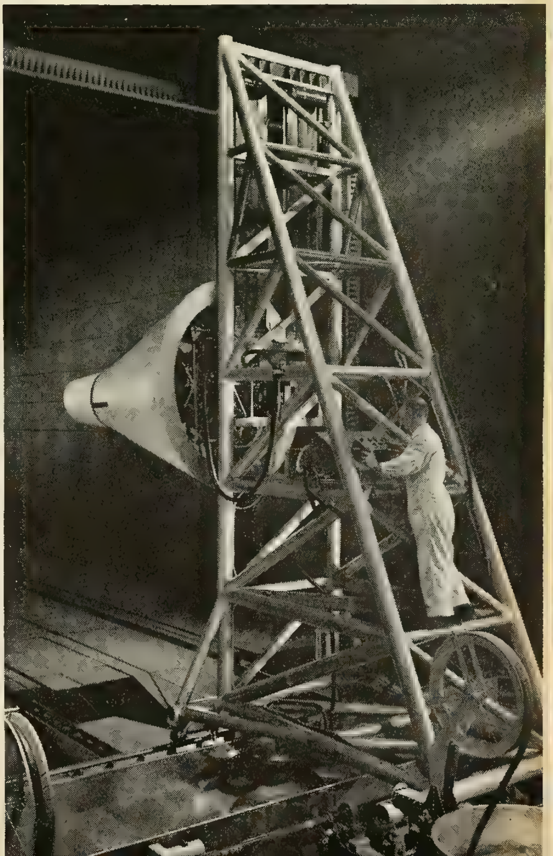
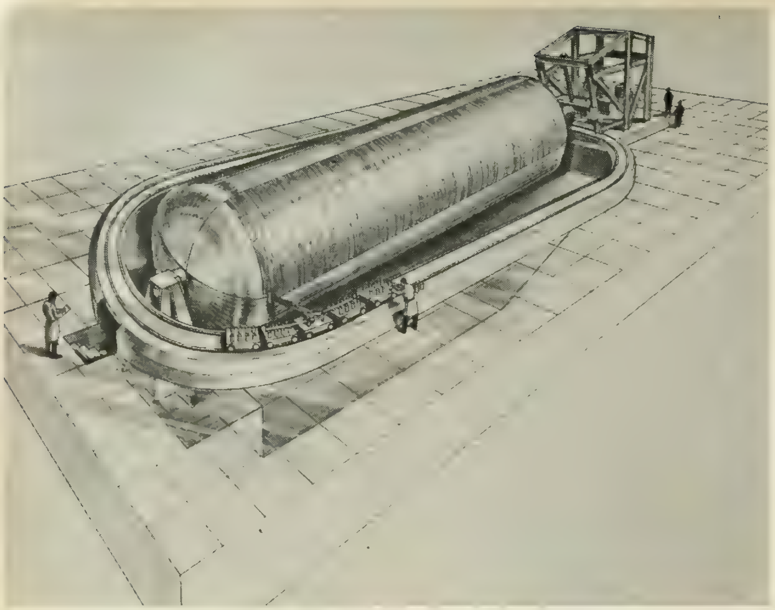
To enhance the nation's capabilities in this vital science, Martin has built a unique Rendezvous, Closure and Docking Laboratory. It simulates for technicians and astronauts all the sensor and control problems of orbital rendezvous, and it utilizes full-scale hardware. It simulates both manual and automatic closure from 100 miles out to lock-on.

This Martin facility will speed the nation's development of rendezvous techniques for manned space systems. At Martin, systems management means the best possible product, in the shortest possible time, at the lowest possible cost.





AEROJET-GENERAL'S proposed 260-in. motor case facility.

(continued from p. 23)

contracting. The propulsion firm also has plans to install three huge winding machines in its Pocatello, Idaho, plant.

One will wind structures up to 156-in. across and 360 in. long. The second will take 60-in.-diameter vessels 150-in. long, and the third will accommodate bottles exceeding 260 in. diameter and 23 ft. in length. (see p. 21).

● **Cryogenic containment**—Research into a number of new applications for filament-wound structures is well underway at Narmco Research and Development, division of Telecomputing Corp. These programs and achievements range all the way from extremely high mass-fraction motor cases through flexible structures to thick-walled bottles.

Narmco researchers have wound pressure vessels that successfully contained liquid hydrogen through the use of special adhesives and a Teflon liner. Their work in thick-wall containers produced one bottle which tested out at 14,000 psi internal pressure—with glass-resin composite stresses of 200,000 psi axial and 273,000 psi circumferential.

The thick-wall bottle program was aimed at solving the problem of fatigue failure in such filament-wound structures after repeated cycling. The Narmco approach consists of separating the longitudinal and circumferential layers with an intermediate layer that does not transmit the deformation of the longitudinal fibers to the resin of the circumferential wrapping.

Owens-Corning Fiberglas is working in this area with an eye toward solving the permeability problems with filament-wound pressure vessels. Experimental structures using filaments and flakes have indicated a potential for containing liquid hydrogen.

OCF is by far the largest supplier of glass filaments to the entire aerospace industry. (M/R April 16, 1962, p. 24). Behind this leadership is an extensive research effort geared to solve many of the critical problems facing both winders and designers. OCF has contracts with the Air Force to pursue the glass end of the picture while the winders develop and optimize their techniques.

While no two approaches to the many data-starved areas within the technology of filament winding are exactly the same, all industrial firms involved in the area conduct research and pilot production efforts along similar lines.

Some, like Rohr Aircraft, pursue mathematical optimization techniques coupled to numerically controlled machines. Others adapt their abilities to the particular segments of the aerospace market they're seeking, and many, with large commercial interests, keep an eye out for non-space applications.

A typical example of the type of work covered by any major winder is found in the approach taken by the Allison Division of General Motors—a major supplier of metal *Minuteman* motor cases.

Early in 1960, Allison inaugurated a company-funded effort directed toward the design and development of full-scale glass filament-reinforced plastic rocket motor cases.

In a short time, the Division burst-tested a filament-wound rocket-motor case built to meet the requirements and dimensions of the *Minuteman* second stage.

Current company-funded programs for the advancement of the state of the art being conducted include:

—Investigation of nondestructive test techniques

—Evaluation of pre-impregnated glass rovings and the impregnation process

—Inter-laminar shear stress evaluation

—Resin system evaluation and selection

—Design and analysis of toroidal pressure vessels

Theoretical and experimental programs on pre-stressed and non-prestressed composite pressure vessels (metal cylinders over-wrapped with glass).

—Design and fabrication of new laboratory winding machines

—Case material optimization studies based on specific mission requirements.

The Allison programs outline the major technical problem areas within filament winding. There is general agreement that materials-testing techniques sorely lack uniformity and standardization. Allison spokesmen maintain that the tests do not duplicate the physical or mechanical environments the final structure will face.

While the major product area for filament winding is in various types of pressure vessels, both for solid rockets and various gas-containment bottles, the process has a vast potential in many other structures. Winding of small aircraft fuselages is another possible application.

The manufacturing flexibility of the process includes the construction of spherical, hemispherical, conical, cylindrical, irregular shapes and flat surfaces.

● **Other winders**—In addition to the firms listed in this report as fabricators, there are many others involved to greater or lesser degrees. Among these are Amercoat Corp., Creative Engineering, Douglas Aircraft Corp., FMC Corp., Lockheed Aircraft Co., Rocketdyne Division of North American Aviation, Swedlow Plastics, Zenith Plastics.

Also Bendix Products Aerospace Division of Bendix Corp., Brunswick Corp., Walter Kidde Co., Lamtex Industries, Apex Reinforced Plastics Division of White Sewing Machine Corp., Goodyear Aerospace Co., Tapco Division of Thompson Ramo Wooldridge Inc., Black-Sivalls & Bryson, Inc., U.S. Rubber Co., and the Boeing Co.

Suppliers of pre-impregnated glass fiber reinforcing materials include Coast Mfg. & Supply, Narmco Resins and Coatings, Chicago Printed String Co., Minnesota Mining and Mfg. and Cordo Chemical Corp. ■

Fundamentals of Filament Winding

A detailed explanation of the process and its various forms, including a résumé of techniques, equipment and major design problems. MISSILES AND ROCKETS *is indebted to R. G. Brown, formerly of Lockheed Missiles and Space Co., for this presentation.*

FIRST STEP in the fabrication of a filament-wound structure is construction of a mandrel. The mandrel forms the contour which will determine internal configuration of the filament-wound structure.

The filaments are wound over the mandrel during the wrapping operation. This mandrel form is maintained within the structure during the subsequent curing operation. Upon completion of the cure, the rigid filament-wound structure is removed from the winding mandrel.

Since the mandrel provides the form or contour of the structure, it also determines the tolerance of the final part. The mandrel must be dimensionally stable during all fabrication processes and it must resist the winding forces. In most applications of filament-reinforced plastic structures, it is desirable to maintain continuous filaments in the finished structure.

This means that most openings in the finished component such as the pressure tank will be relatively small with respect to the major diameter of the component. The mandrels used must be of a type which can be removed by destruction of their basic properties. In addition to segmented steel, the mandrel may be fabricated of a plaster, a low-melting temperature alloy, or some water-soluble materials that allow removal of the mandrel material from the finished article through very-small-diameter holes.

Since plastic-reinforced components such as pressure vessels are permeable, the next operation in the fabrication is to provide an internal liner. These are usually fabricated of Buna rubber or some similar type of rubber or elastomeric material. For large production, the liner is usually molded into a uniform, void-free structure. The liner must be compatible with the material or gasses contained within the finished pressure vessel.

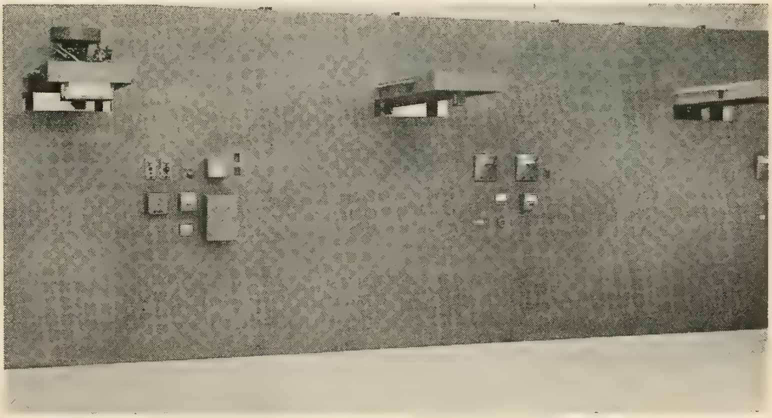
After the liner has been fabricated or installed and the pressure bosses, which provide the ports or openings in a completed structure, are located on the mandrel, the next operation is the actual winding. During winding, the filaments are usually impregnated with a suitable resin system and are placed on the mandrel in some predetermined pattern. The winding pattern is calculated on the basis of the loads to which the plastic component will be subjected.

To provide a high-production-rate filament-winding machine, the filaments are usually oriented in the form of a tape prior to the actual winding operation. This allows the placement of a number of filaments, side by side, in one pass of the winding equipment.

After all of the filaments and resin have been applied to the component, the completed structure is cured. The curing oven subjects the component to an elevated temperature cure which polymerizes the resin system. Time and temperature of the cure is a function of the resin material being used and the physical properties desired in the completed part. After completion of the curing cycle, the mandrel is removed by disassembling or washing.

- **Fabrication techniques**—The requirements of a filament-winding machine for a filament-reinforced plastic structure are to provide tension to the fiber being wrapped, to locate the filaments very accurately, and—usually—to impregnate the filaments with the plastic resin.

Filament winding is applicable to structures represented by a surface of revolution. The motion transcribed by the winding equipment is usually that of some combination of rotational and linear motion.



AEROJET'S three fiberizing furnaces: 204-hole at left; single-hole at center; and another single-hole at right. Last will be atmospherically controlled.

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There are many ways in which the filaments may be oriented on a filament-reinforced structure. Thus there are many types of equipment or mechanisms which can be used to orient the fibers. Nearly every manufacturer of filament-reinforced structures has indicated a preference in the type of winding equipment for its particular operation. But there are only a limited number of motions which can be incorporated in winding equipment to transcribe the correct winding pattern onto the desired shape.

Basically, there are only three options in the mechanism of winding. First, the mandrel or the part to be fabricated can be rotated and the filaments discharged from a fixed point. Second, the discharge point may rotate around the mandrel or the part to be fabricated. Third, the discharge point may traverse linearly, while the mandrel rotates. Filament-winding equipment or machines can therefore be considered to be of three major classes: lathe-type equipment, tumble-machines, and rotating-arm machines.

- **Lathe-type**—The lathe-type winding machine is composed of a carriage which discharges a filament as it travels from one end of the shape to the other. This motion is coupled to the rotating of the mandrel in such a way that the desired wrap angle is inscribed.

The ratio of rotational speed to the traversing speed of the discharge point dictates the angle the filament will make with a longitudinal axis of a component. The traversing motion of the carriage is usually linar during the fabrication of a cylindrical section, but changes in velocity in order to overwrap spherical or conical ends.

Upon reaching one end of the traversing length, the discharge point is indexed in toward the longitudinal center line; after the end section (such as a dome in a cylindrical pressure vessel) is traversed, the carriage returns to its original starting point. Upon return to the original starting point, the axis of rotation is automatically indexed for the next wrap. This provides a side-by-side progressive coverage of the entire shape, and avoids winding the filaments directly over the previous wrap.

The lathe-type winding equipment can fabricate helically wrapped chambers in which the wrap angle is constant and usually fairly steep, i.e., 54.75 degrees for an optimum-wound, internally pressurized cylindrical vessel, or for very small helix angles which approach the composite hoop and longitudinal type of wrapping techniques.

To accurately produce the desired filament positioning, the traversing carriage mechanism should be directly coupled to the rotating mechanism. Electrical or hydraulic interlock systems are best suited for accurate reproducibility, but mechanical drives can be used satisfactorily where the dimensions of the end item are relatively small. The correct motion of the discharge point can be reproduced by a number of mechanisms, but is generally programmed with cams. Some of the more sophisticated designs have suggested numerically controlled systems with hydraulic actuating devices for the traversing carriage.

The disadvantage of the lathe-type machine is that for any shape other than cylindrical, a change in velocity of the traversing carriage is necessary. The acceleration and deceleration of the carriage system in order to cope with changes in contour results in problems caused by the high accelerations and decelerations of the carriage discharge point. Usually, the carriage and discharge point are of a mass sufficient to require very high horsepower and torque-rating drive mechanisms.

- **Tumbling**—The tumble machine essentially, rotates the mandrel end over end while the discharge point remains stationary. This type of equipment is usable for applying longitudinal fibers on elongated shapes.

The mandrel on which the filaments are to be located is usually supported on one end of the axis. The part is located slightly off-center from the vertical plane to provide the ability to wind around bosses or other openings. The design requires at least one boss, through which the mandrel is supported during the winding operation. As the mandrel is tumbled end over end, it is also indexed by a coupled mechanism such that the radial location of the filaments is inscribed.

The tumble machine is desirable for fabricating rather small filament-reinforced structures. The discharge point of the filament remains stationary, and in-process impregnation techniques can be used without encountering the problems of containing the resin during movement or rotation. Also, since the discharge point remains stationary, the problem of guiding the filaments through a mechanized winding arm is minimized. This minimizes fraying or breakage of filaments during the winding operation.

Obviously, this type of system is size-limited. As the size of the mandrel becomes larger it becomes heavier. Supporting a heavy mandrel from one end, and rotating this eccentric load around a given axis, imposes terrific design problems because of the loads on the machine. The tumble-type winding machine is very cheap to fabricate. But because of the bending of an eccentrically located heavy mandrel, the tumble machine is usually restricted to the fabrication of small filament-reinforced plastic structures.

- **Rotating arm**—The rotating arm winding machine probably is the simplest of all the machines to design and fabricate, but it produces reliable reinforced-plastic structures.

The discharge point of the filaments is located at the end of a rotating arm—the arm rotating around the shape as it is being indexed in the other plane to provide even filament coverage. The rotating arm is usually used in the placement of longitudinal fibers on elongated cylindrical shapes though it can be used for fabrication of spherical shapes.

The simplicity of this equipment is such that it can be made strong enough—and by proper suspension, accurate enough—to make very reliable structures. With electric or hydraulic interlocks between the rotating mechanism and the winding arm, the highest accuracy can be obtained in the placement of longitudinal filaments.

The rotating arm machine has some inherent disadvantages. First, the mass of the arm must be as low as possible; the discharge point most likely will not be able to support tensioning devices in the spools of filaments. This requires, the guiding of filaments through the length of the winding arm onto the discharge point.

Since the motion of the winding arm is rotational, it also is very difficult to provide in-process resin impregnation techniques. A resin bath which can be rotated 360 degrees would be required. This disadvantage has been overcome by the use of pre-impregnated materials.

The third disadvantage of the rotating arm equipment is that the discharge rate is not linear and the discharge rate over the dome of the cylinder is not the same as the discharge rate along the cylindrical surface. This may be of questionable significance, but the tensioning devices usually used have a velocity dependency. The rotating arm machine, like the tumbling machine, usually is used for hoop and longitudinal-wrap cylindrical vessels or spherical shapes.

When a cylindrical vessel is being fabricated, a second winding mechanism is required for placing the hoop wrap or circumferential wraps on the cylindrical section. This is usually a traversing mechanism provided by a screw-thread type system providing a level wind of circumferential filaments spaced very close together. The movement of this longitudinal traversing carriage is at a very low lead angle—after one revolution, each filament is placed directly next to the preceding filament, providing there is no gap between circumferential filaments. ■

special report:
FILAMENT WINDING

B. F. Goodrich Building Largest Segmented Case

THE WORLD'S LARGEST filament-wound, segmented motor case is under construction at B. F. Goodrich's new $2-million facility near Akron, Ohio.

The 156-in.-dia. case is part of the Air Force program in filament-wound structures. Goodrich is winding two units for Thiokol Chemical Corp., prime contractor on the segmented case program.

The 156-in. cases will be wound on a one-of-a-kind machine capable of creating pressure vessels of that diameter and up to 35 ft. long—the maximum size for shipment. The contract calls for two of the huge motor cases—one earmarked for hydroburst and the other to be proof-tested to design specifications.

The vertical winding machine can perform polar, helical and geodesic patterns in the longitudinal direction, as well as circumferential winds under precise control. The unit is programmed through a Data-Track system—permitting controlled winding of any mathematically identifiable pattern.

While B. F. Goodrich has broad capability in glass-filament formulation, Glen Zimmerman, New Product Director of the Aerospace and Defense Products Division, says the 156-in. program will utilize commercially available glass.

The winding machine employs a Goodrich-developed wet-winding method which coats the glass filaments during the fabrication operation. The resin is applied by a series of bushings through metered pressure. Only the exact amount of resin necessary is applied.

The resin itself is A-staged until final structure cure. The whole assembly—mandrel, case, winding machine and controls—is in a temperature/humidity-controlled area.

- **Other equipment**—Besides the large winding unit, Goodrich has three other winding machines in the integrated facility—two polar winders capable of winding chambers up to 6 ft. in diameter and 12 ft. long; and a cam-controlled helical-winding unit capable of handling chambers 4 ft. in diameter and 8 ft. long.

The plant also contains all items of special equipment necessary for inspection and receiving of raw materials, mandrel preparation, curing and final inspection—all arranged for efficient process flow.

There is also a 5,000-ton molding press for fabrication of insulators for solid-propellant motors. The control lab is equipped to handle a complete job of materials testing, including qualification tests on filaments, resins and catalysts as well as the in-process controls.

The vertical curing oven, capable of handling the largest case fabricated at the site, has a turntable to assure uniformity of cure. The maximum temperature of the 5-million-Btu, indirect gas-fired oven is 500°F.

Goodrich obviously has chosen to pursue the 156-in. work rather than the 260-in. glass motor case. The entire facility is geared to produce the biggest pressure vessel possible within current shipping limitations.

- **Ideal donut**—The division is in the midst of an extensive program to develop a practical design for filament-wound, toroidal-shaped pressure containers.

The basic concept is isotensoid, with the meridian windings essentially in a radial direction. Peripheral restraint winds are positioned either at the I.D. or at the torus O.D.

Design analysis shows that the torus shape is ideal for complete utilization of filament materials. It results in an overall volume-to-weight efficiency comparable to the cylindrical section of a balanced-design filament-wound cylinder.

A major advantage of this shape is that the efficiency is independent of size—to contain a given volume at a fixed pressure, the weight of the torus is independent of its size; two torus containers of half volume would have the same weight as one container of full volume, ignoring liner and inner connective fittings.

Goodrich has built prototype ma-

CHECKOUT CASE on Goodrich's New 156-in. polar winding machine.

chinery and a number of torus containers have been fabricated and tested. The devolpment program centered around a 65-in.-O.D. torus of 13-cu.-ft. internal volume.

Prototype unit testing has confirmed the mathematical analysis and proved out the inherent stability in the construction techniques and winding angles. Present equipment can wind torus containers up to 8 ft. in outside diameter and up to 25 in. in cross-section. A production unit has been designed to handle containers up to 215-in.-O.D. and 6-ft. cross-sections.

Torus tanks are ideal for space-limited applications. The units could surround the nozzle area as a liquid thrust-vector-control supply—and even be hooked in tandem. Internal baffles and expulsion diaphragms can be incorporated as required into the design.

- **Glass-making ability**—Backing up the filament-winding facility and its supporting engineering is a broad research competence in the actual art of making filaments from the raw material. BFG is one of only three such industrial complexes in the missile/space filament-winding industry. The others are Owens-Corning Fiberglas and Aerojet-General Corp. The former is a major glass supplier with a research capability in filament winding; the latter is a propulsion firm with production capabilities in filament winding and a research facility in glassmaking.

The research effort at BFG has concentrated largely on achieving glasses with high tensile strength, but a limited amount of work has been directed toward high-modulus compositions.

The division is deep in glass technology, and has formulated and evaluated more than 1,000 widely varying glass compositions. Facilities for making glass from raw materials are combined with capabilities in spinning from three furnaces—a single-hole, a 50-hole and a 150-hole platinum bushing.

Research programs in glass start with the formulation, mixing and melting and conversion to marbles. Then the glass is spun from a single-hole platinum bushing for a single-filament evaluation. The two larger units provide enough filament of the composition under study to allow evaluation as strands, NOL tensile rings and small filament-wound bottles.

The division has been involved in a broad program aimed at developing glasses with fiber tensile strengths higher than the commercial "E" glass.

The program objectives narrowed the formulations considerably. BFG researchers were looking for tensile strength 50% higher than "E" glass, an elastic modulus greater than 11×10^6, good fiber-forming properties and stability in resin-glass composites.

The highest fiber tensile strengths were found in the magnesium-aluminum silicate, borosilicate and calcium-aluminate glass compositions. The BFG 2968 magnesium-aluminum silicate glass fiber checked in with a tensile strength of 621,000 psi, a modulus of 12.0×10^6 and a density of 2.45 gm/cc. Single fibers of this composition have been measured and found to have tensile strengths in the 1-million-psi range.

- **Four target areas**—As a result of the program, BFG researchers have outlined four major areas needing more work—development of a beryllium-free high-strength, high-modulus glass; development of a beryllium-containing glass in the same area; development of a stable low-density glass with high strength, and development of a low-modulus, but high-elongation, glass fiber.

Researchers at BFG feel a non-beryllium glass with an average tensile strength of 700,000 psi, 0.00036 in. diameter, and a modulus of about 14.0×10^6 with a density of 2.5 gm/cc can be developed.

In the area of low-density glasses, a combination of vitreous silica and boric-oxide glasses should achieve the desired result. The 100% boric-oxide glass has the lowest density—1.86 gm/cc but picks up moisture rapidly. The vitreous silica has a density of 2.20 gm/cc and is relatively stable in the atmosphere. Such a low-density combination is aimed at weight-conscious applications.

BFG experts are not sure an ideal low-modulus/high-strength glass can be developed, but they feel reasonably certain that one with a modulus of 3×10^6 may be achieved.

With this in mind, they plan to utilize those oxides known to cause a lowering of the modulus in making silicate glasses. Silicate glasses are specified because their structure should enhance the strength.

Low-modulus and high-elongation glasses should give more flexibility in fiber-glass composites. In addition, where stress is localized it can be distributed more readily by the action of local high elongation. ■

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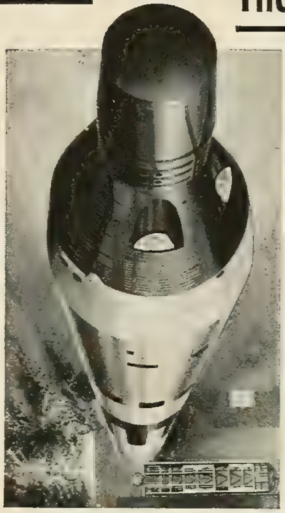

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special report:
FILAMENT WINDING

Resin-Testing Methods Pose Standards Problem

A MAJOR PROBLEM facing any filament winder lies in effective analysis of the component parts of composite structures.

The glass itself can be subjected to a number of tests and results have often shown agreement among the various organizations involved in testing any particular formulation. But the resin systems pose another problem. There are so many variations possible, and so many different physical and chemical properties that simple, standard evaluation procedures are rare.

Dr. L. Rubin, staff engineer at Rohr Corp., Riverside, Calif. is one of the many concerned with this problem since Rohr is greatly interested in filament winding on a subcontract basis.

Rubin and his colleagues at Rohr are constantly evaluating reinforced plastic compositions for applications in a variety of structures ranging from the F-1 nozzle skirt extension to aircraft components.

But the other half of the filament winding story—before the reinforced stage is reached—deals with the resin. It protects the glass from abrasion, locks individual fibers in place, and takes up and distributes the applied loading on the glass.

Although the product quality and use of pre-impregnated roving is rapidly increasing, Rubin says there are still broad areas where wet winding is used.

With this in mind, Rubin detailed the evaluation process used at Rohr to determine the capabilities of a resin system in wet winding. The test procedure is precisely the same in wet winding as it is for pre-pregs—except in phases that are suitable only for the resin system minus reinforcement material.

• **Flow mold method**—Rubin has developed a method using a flow mold to determine the percentage of resin flow in pre-preg roving. The mold is actually a two-part punch-and-die arrangement which, with the application of heat and pressure, causes the excess resin to flow out axially to the roving.

Rubin says the flowable resin is extruded in a measurable form. This test is the main difference between the two Rohr procedures in evaluating wet wind resins and pre-preg materials.

The suitability of synthetic resins for filament winding may be determined by many physical and chemical characteristics of the resin systems, all of which are independent of the actual winding operation. The properties described are used to provide a preliminary screening of these resins according to Rubin. Ultimately, the resin must be used and tested as part of a resin/glass filament-wound composite.

The second phase of the Rohr evaluation program includes filament winding of test specimens. Since epoxy resins are those in greatest use for filament winding, three types of resins within this broad classification have been chosen to illustrate the evaluation procedure.

It is necessary to see how the chemical and physical properties, and their ultimate performance, are affected by the use of different curing agents with each resin. Each resin, says Rubin, was cured with an acid anhydride, an aromatic amine, a new boric acid ester of glycol and a substituted aliphatic amine and a catalytic curing agent.

• **Surface charactertistics**—For use in filament winding, first consideration must be given to the physical suitability of the resin for wetting out and impregnating the glass roving. Rubin assumes a prior choice of a resin-compatible finish on the glass. The most important resin property related to glass roving impregnation is the viscosity of the resin. Viscosity is a function of temperature, and a temperature-viscosity curve is determined for each resin system.

To attain a useful working viscosity, the resin must be maintained at an elevated temperature. This requirement generally poses no great processing problem, except where the possibility of an accelerated resin cure exists at the higher temperature. The next step in the resin evaluation is determination of gel time at various temperatures.

Gel times that are expected to run longer than a few minutes are determined by means of a constant temperature bath and a MOL-REZ gel time meter. This device lowers and raises a small weight into a vial of catalyzed resin at predetermined and timed intervals. As viscosity of the resin increases to the gelling point, the weight can no longer be removed from the vial and the meter automatically shuts down.

For each resin being considered, the minimum temperature required for attaining a viscosity of 1,000 centipoises or less and the gel time for each of three temperature levels are established. At this point, the initial suitability of a resin for filament winding can be determined, since a reasonable working life at the optimum winding temperature is required.

For example, the resin ERL-2258 (see resin table) has a satisfactory viscosity at room temperature with each of the curing agents used, and the gel time for each system is sufficiently great so that a long winding time is available.

• **DER-332 characteristics**—The resin DER-332 exhibits a satisfactory room temperature winding viscosity with HHPA and MNA, Rubin says. Gel times at this temperature provide an adequate working life for the resin. With the aromatic amine, the resin must be heated to 100°F to attain a 1,000-cps viscosity. The gel time at this temperature is approximately nine hours, giving this resin/curing agency system considerably less potential usefulness for filament winding than those previously mentioned.

The epoxy-novolac resin, DEN-438, requires an elevated temperature with each of the curing agents to attain a minimum 1,000-cps viscosity. The gel time at the required winding temperature, however, is relatively short. Even under the best conditions, with the MNA, as an acceptable winding temperature is reached, the gel time is less than 40 hours—not considered an adequate practical working life.

For this reason, the DEN-438 resin systems are not considered satisfactory for wet winding although they are quite amenable to pre-impregnated roving, in which coating of the glass is achieved from a solvent solution of the resin.

Having determined the practicality of a resin system for filament winding, further evaluation is carried out to yield information on its strength and thermal properties. For these purposes, cast bars of each resin system are prepared from which specimens for tensile strength (ASTM D638-58T), flexural strength

(ASTM D790-58T) and heat distortion (ASTM D648-56) determinations are obtained.

Tensile specimens are milled from the rough castings on a Tensil-Kut machine. The test fixture is specially designed so that the necked-down region of the specimen cradles in the fixture testing machine grips. Results showed that the greatest tensile strength for each resin is achieved with an aromatic amine curing agent, while the lowest values result from those resins cured with MNA.

- **Flexural strength**—Resins cured with HHPA show the greatest flexural strength, says Rubin. All the resins show a high flexural strength when cured with aromatic amines.

Before the resin is used in a filament-wound structure, some indication of its stability at elevated temperatures should be obtained. A preliminary screening is accomplished by means of the ASTM heat-distortion test.

While the physical, thermal and handling characteristics of a given resin system are useful for a preliminary screening, their performance in a filament-wound structure is the most important phase of an evaluation program. The most universally accepted filament-wound test specimen to date is the NOL (Naval Ordnance Laboratory) ring specimen.

Test windings for this program were made with Owens-Corning 20-end HTS finish "E" glass roving. Each resin was maintained at the temperature required to give a viscosity of 1,000 cps or less during the winding operation. Impregnation of the glass roving was accomplished during the windings. All windings were made on a cylindrical steel mandrel of 5.75-in. diameter and 9 in. long.

- **Overall results**—A summary of resin performance measured by the hoop tensile strength of the systems under consideration shows the highest hoop tensile strength was obtained with each of the resins when cured with a curing agent of the aromatic amine type.

The best wet strength retention—measured by hoop tensile strength after six hours' immersion in boiling water—is shown by an anhydride cured resin. Measured at a temperature of 300°F, each resin exhibited its best hoop tensile strength when it was cured with an aromatic amine curing agency.

COMPARATIVE EVALUATION OF EPOXY RESIN PRE-IMPREGNATED GLASS ROVING

AVERAGE VALUES	3M COMPANY XP-230	BLOOMINGDALE RUBBER CO.	COAST MFG. CO. 612	CORDO MOBALOY ER	CORDO MOBALOY EI	U. S. POLYMERIC E-787	CHICAGO PRINTED STRING (S-994)*	AIR LOGISTICS (S-994)*
Composite Hoop Tensile Strength (psi)	236,300	225,600	211,300	236,800	215,800	239,100	284,200	279,200
Resin Content %	14.46	16.80	15.70	12.87	12.02	17.45	11.00	14.10
Hoop Tensile Glass Stress (psi)	336,100	336,500	307,600	331,600	295,700	358,700	435,100	379,100
Hoop Tensile Wet Strength (psi) (1)	215,700	176,100	182,100	123,300	182,700	186,700	208,600	291,700
Hoop Tensile 300°F Strength (psi) (2)	191,300	175,500	127,000	145,500	181,000	142,700	233,300	243,100
Horizontal Shear Strength (psi) (3)	8287	9858	7392	7459	6413	8799	11,604	11,134

(1) Composite stress—specimens tested at room temperature after six hours immersion in boiling deionized water.
(2) Composite stress—specimens tested at 300°F after 15 minute exposure at 300°F.
(3) Short beam shear of NOL ring segment.

NOTE: All glass is 20-end HTS roving except (*) which is S-994 20-end roving.

The shear strength of each resin system is given as measured by the horizontal shear method. The highest horizontal shear values for DER-332 and DEN-438 are those attained with an aromatic amine curing agent. The diepoxide ERL-2258 shows the highest shear value with USB-110, which is essentially a tertiary amine, and the next highest value was obtained with the proprietary aromatic amine blend ZZL-0820.

Without exception, the lowest shear values were obtained with the catalytic curing agent BF_3/MEA. With some exceptions, the lowest hoop tension values for each resin under each test condition was shown with the BF_3/MEA curing agent.

- **Data correlation**—The most interesting attempt at data correlation involves equating a resin's performance as a casting with its performance in a filament-wound specimen. Reconsideration of the viscosity, gel time and resin-casting data shows that the best overall handling characteristics and mechanical properties were achieved by the ERL-2258 resin.

Heat distortion temperature was best for the DEN-438, but it is not desirable as a wet-winding resin because of its poor handling characteristics.

A consideration of the filament-winding data would also support elimination of DEN-438 as a wet-winding resin, since all values, except horizontal shear, are inferior to those obtained with the other two resins. Even in shear, the curing agent used is not practical for winding.

EPOXY RESINS

	ERL-2258	DER-332	DEN-438
Manufacturer	Bakellite (Union Carbide)	Dow Chemical	Dow Chemical
Type	Peracetic acid derived Diepoxide	Purified Diglycidyl Ether of Bisphenol-A	Epoxy-Novolac
Epoxide Equivalent	130	179	175-182

The standard diglycidly ether resin DER-332 showed the highest overall hoop tensile strength at room temperature and at 300°F. In both cases, however, the curing agent used was the aromatic amine mixture, MPDA/MDA. A review of the temperature/viscosity curves and gel times shows that this system does not have an adequate working life at the required winding temperature to be seriously considered.

The system ERL-2258/ZZL-0820 showed the second highest hoop tensile strength. The second highest hoop tensile strength at elevated temperature is shown by the DER-332/USB-110 system, but this resin combination has a serious shortcoming in its lack of wet-strength retension, Rubin says. The next highest hoop tensile strength at elevated temperature is shown by the system ERL-2258/ZZL-020. The highest overall wet strength retention measured by hoop tension testing is shown by the resin ERL-2258 cured with HHPA, while the next best value was achieved by the DER-332/MNA system.

While other properties of both parent resins and filament-wound structures may also be important in a final evaluation of resin suitability for filament winding, the evaluation methods presented here cover the areas of major concern, giving a good indication of a resin's potential performance in a structure, according to Rubin.

In the final analysis, Rubin says it is not always possible to choose the resin exhibiting the best characteristics in each category, but a broad look at many different test results will indicate a resin system that continually appears among the top few.

Among the resins evaluated here, ERL-2258/ZZ1-920 satisfies this criterion. This wet-winding system has been used to make a wide variety of filament-wound structures. ■

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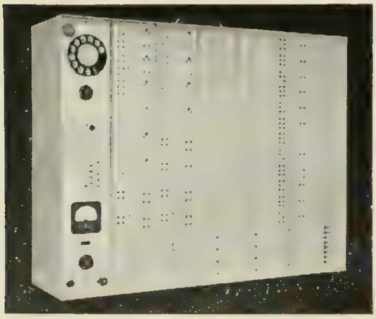

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Polymeric
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THE FIRST major innovation within the state-of-the-art in filament winding came with the introduction of pre-impregnated roving—an attempt to overcome the quality control and uniformity problems inherent in early wet winding techniques.

One of the major pre-preg suppliers is U.S. Polymeric Chemicals, Inc., one of the first in the field with a full-scale filament impregnation plant. The process of pre-impregnation simply involves the coating of glass fiber roving with suitable resins and slightly curing the composite before rewinding and shipment to the end fabricator.

But the possible variations in resin systems for filament winding are almost infinite—which essentially means the pre-impregnator is a specialty producer. The choice of resin system and sizing is mainly determined by the particular structure to be fabricated.

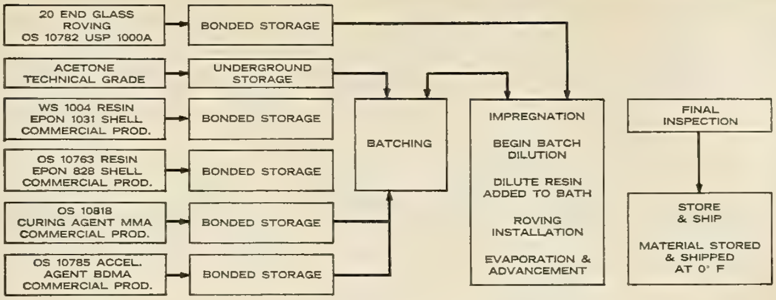
The main reason for pre-impregnation lies in quality control and process standards. This is tied directly to the whole field of filament winding—the main objection has always had its basis in the elements of process control as related to the reliability and uniformity of the end products.

Pre-impregnation, once all the variables are fixed, is a deceptively simple process. It consists of unwinding spools of raw glass roving, suitably sized, and running the roving through baths of the chosen resin.

The coated roving is then run through a vertical curing oven where the resin is B-staged, i.e., advanced to a partial state of cure. It is then rewound on disposable spools, packaged and shipped to the filament winder.

U.S. Polymeric's facility can impregnate 55 roving strands at a time. Resin content, degree of advancement and winding tension on the mandrel all relate to the practical production problems faced by any winder, and Polymeric has built a pilot filament-winding machine to evaluate its own processes and innovations in resin-glass

Leader in
re-Pregs


20 END GLASS ROVING OS 10782 USP 1000A
BONDED STORAGE
ACETONE TECHNICAL GRADE
UNDERGROUND STORAGE
WS 1004 RESIN EPON 1031 SHELL COMMERCIAL PROD.
BONDED STORAGE
OS 10763 RESIN EPON 828 SHELL COMMERCIAL PROD.
BONDED STORAGE
OS 10818 CURING AGENT MMA COMMERCIAL PROD.
BONDED STORAGE
OS 10785 ACCEL. AGENT BDMA COMMERCIAL PROD.
BONDED STORAGE
BATCHING
IMPREGNATION
BEGIN BATCH DILUTION
DILUTE RESIN ADDED TO BATH
ROVING INSTALLATION
EVAPORATION & ADVANCEMENT
FINAL INSPECTION
STORE & SHIP
MATERIAL STORED & SHIPPED AT 0° F

Poly Preg Flow System

● **Process flow**—Polymeric has initiated a stringent in-process control system to achieve complete uniformity in the coating of any given spool. To illustrate the complexity behind the impregnation process, J. A. Martenson, Manager of New Product Development organizes the Poly Preg flow system in the form of a chart (above).

Each diagramatic block represents up to ten individual chemical or physical quality assurance tests. Documentation is maintained on information from these stations to allow complete review of properties of a given run. This procedure has been used for all materials produced at Polymeric, and has provided maximum analytical data in a short time.

Chemicals are evaluated by comprehensive tests to insure both specification and inherently reproducible characteristics. Acceptance tests for resins and curatives include specific gravity, refractive index, viscosity, boiling range, epoxide equivalent, hydroxyl content, gel time and infrared spectra analysis.

Mixing of the chemicals into the desired composition is done on a large scale to provide a single resin mix for a complete lot of pre-preg material. Reproducibility is increased by exhaustive testing of samples from this large mix at a very low unit cost. Resin mixes not conforming to specification are rejected prior to impregnation—effecting significant savings in expensive materials such as the S-994 glass roving. In addition to chemical tests, a variety of physical tests are performed on the raw materials. Glass roving is evaluated on the basis of end count, ignition loss, weight-per-lineal-yard, tensile strength, shear strength package durometer, and catenary. Adherence to U. S. Polymeric and military specifications such as USP 1000A and WS-1126A, insures a consistently high quality level of material.

● **Control to shipment**—After raw materials have met acceptance tests, they are properly designated and stored in bonded and temperature-controlled areas.

Quality assurance continues through the production run. In-process evaluation and control during impregnation, polymerization and wind-up includes temperature recording controllers and precision feed-rate equipment.

Outgoing quality control testing of materials includes analysis of tensile strength, shear strength, resin content, volatile content, flow, gel time, and weight-per-lineal-yard. This area is receiving continued attention so as to develop more and better test methods to define optimum material.

Testing at this point makes use of Polymeric's extensive physical test laboratory. Strand tensile, and NOL horizontal shear tests, both at elevated temperature and at room temperature after water boil, are run on each lot. Physical tests can also be accomplished on a routine basis from −100° to 1000°F.

Facilities in this lab are also available for complete electrical testing, as well as for coefficient of thermal expansion, shrinkage, coefficient of thermal conductivity, and heat distortion temperature.

One new test method includes a viscosity refractive index test to better define the exact state of "B" stage.

● **Hollow glass**—Although S-994 glass shows a great increase in tensile strength over standard "E" glass, the increase in modulus is only 14%. For many applications a higher modulus is necessary to maintain required rigidity.

The YM-31A glass composition with a modulus of 17×10^6, shows an increase of 62% over "E" glass, which answers this need.

Because the YM-31A formulation contains beryllia, certain precautions must be taken during handling—which slows development. Procedures have now been documented for handling, and the developmental program is being accelerated.

One unique new material is hollow "E" glass fiber. These fibers, with average outside diameter of only 0.0006 in., are actually 42% hollow.

Although the basic strength of the hollow fibers is lower than that of solid fibers, a fabricated part of equal weight has increased rigidity. This is extremely important in applications such as deep submersible vessels. These raw fibers are rather brittle, and so again, extreme care must be exercised in processing to obtain optimum results.

The Poly Preg process used to coat these fibers is such that the fibers are encapsulated by a protective epoxy layer at an early station. Careful handling through the balance of coating and "B" staging has demonstrated the effectiveness of the process.

A typical resin content by weight for solid fibers in filament-wound applications is 19%. This must be raised to approximately 28% to provide an equivalent volume fraction for hollow filaments.

The "hollowness factor" defined either as the total percent hollowness of the composite, or as percent hollowness of the glass phase alone, is a useful and meaningful value.

The impregnation of filament roving is but a small section of U.S. Polymeric's overall capability. The firm processes paper, fiber glass cloth, mats, synthetic fibers, cotton and other fibrous materials by impregnating with a variety of plastic resins and rubbers.

The firm has three treating facilities located in its Stamford, Conn., plant and four in the Santa Ana, Calif., location. There is an expansion program in effect which ultimately will increase the Santa Ana facility by 27,000 sq. ft. The new addition will house equipment and apparatus for expanded research and development in ultra-high temperature and high strength pre-impregnated plastic materials for use in solid and liquid rocket ablative motors.

The firm is also deep in the processing materials for tape-wound nozzles and other high temperature components on launch vehicles. ■

Higher Winding Speeds in Offing

A NEW IMPREGNATION process, which eliminates all filament movement by coating the spools in the as-received condition, may lead to higher winding speeds in fabrication of filament-wound structures.

Developed by the Stratoglas Division of Air Logistics Corp., the process is considered proprietary and samples are under evaluation by private firms, rocket case producers and a number of Government bureaus including the Brooklyn Navy Yard where it is being tested for use in deep submersibles.

Air Logistics spokesmen say the package impregnation method uses a new crystalline epoxy resin that results in the coated spool emerging dry from the impregnation and only "wets" when heated before actual winding operations.

This results in wet winding from a dry pre-preg. The resin system is also proprietary but it is known that it affects the glass surface. Although dry, the resin possesses lubricity that fosters high winding speeds. Resin control is said to be ±2%, and often quite lower.

The semi-crystallized resin is A-staged and remains in this condition until the final wound structure is cured. There is no B-staging involved. The full viscosity of the resin is used during winding.

With more than four years of testing experience, Air Logistics experts claim uniform penetration and coating in each individual spool with consistent, uniform results from spool to spool.

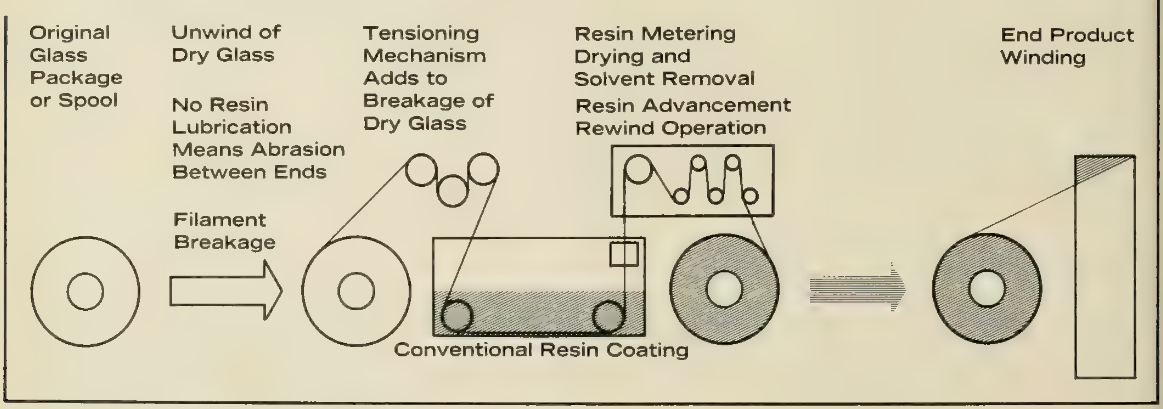
The entire impregnation process eliminates the standard unwinding-coating-rewinding performed in the usual filament-impregnation operation. It also eliminates the complex quality-control steps involved. The main advantage in keeping the glass on the spool is that it removes any possibility of filament damage.

The Stratoglas resin system is the result of an in-house, company-financed development program. Air Logistics experts say the resin optimizes the interface bond, upgrading physical properties. These epoxy-type resins are solvent-free, non-toxic and retain their semi-crystalline condition until final cure.

Information on the resins themselves is regarded as proprietary and just exactly what "semi-crystallization" is in a reinforced plastic resin system is not defined.

The firm intends to market both filament winding pre-preg (Stratoglas 660FW) and wide tape pre-preg (Stratoglas 660ST) with initial emphasis on the filament area. ■

CONVENTIONAL LINEAR IMPREGNATION


Original Glass Package or Spool
Unwind of Dry Glass
No Resin Lubrication Means Abrasion Between Ends
Filament Breakage
Tensioning Mechanism Adds to Breakage of Dry Glass
Resin Metering Drying and Solvent Removal
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End Product Winding
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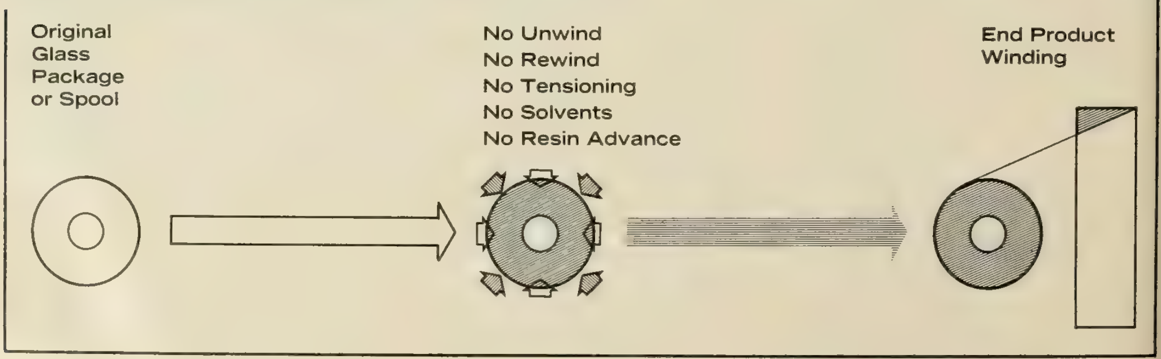
AIR-LOG STRATOGLAS "PACKAGE" IMPREGNATION



CEBM Unit To Check Polaris Cases

THE FIRST COMPLETE nondestructive test device specifically engineered for evaluating filament-wound rocket motor cases is being installed at the Sacramento, Calif., plant of Aerojet-General Corp.

The test complex is the result of a cooperative research effort between Aerojet and Magnaflux Corp., Chicago. Magnaflux initiated the program and Aerojet then joined with engineering and other technical assistance.

The CEBM (Corona, Eddy current, Beta ray, Microwave) system consists of six main components and will be used initially to automatically check the structural integrity, glass-to-resin ratios and inner wall thicknesses of the *Polaris A3* motor chambers.

A portable eddy current instrument included in the system will determine the inner rubber wall thicknesses around the dome-shaped end closures of the glass-wound motor cases.

With the CEBM system, a two-man crew can test an entire chamber in less than eight hours. The system has a 35-ft. by 6-ft. carriage assembly, a central instrumentation console and fixtures for the individual testing methods.

The motor case is mounted on the carriage assembly, which provides simultaneous transverse movement and rotation of the chamber. The case rotates at 1.04 to 4.16 rpm. It moves transversely at 0.7 to 4.2 rpm, presenting the entire surface to the microwave, beta-ray and corona test systems. Unit controls and two strip-chart recorders are housed in the central console.

In operation, the chamber is checked through four separate techniques.

- **Beta-ray backscattering**—This system measures the density of the chamber skin by determining the specific resin-to-glass ratio. Resin-rich and resin-starved areas are recorded. The location of the latter is crucial, since a resin-starved area may result in bond failures, filament chaffing and low strength points.

The beta-ray system has a nuclear gage that emits beta rays from a strontium-90 radioisotope. As this radiation penetrates the skin, the portion that is reflected or backscattered is recorded on one of the strip charts. Since the atomic numbers in the glass composition and the epoxy resins differ widely, the coefficients of reflection are different.

These variations in the amount of backscattered radiation are recorded for each material and then easily translated into specific data on the glass-to-resin ratio of the skin. The beta ray scans a one-square-inch area.

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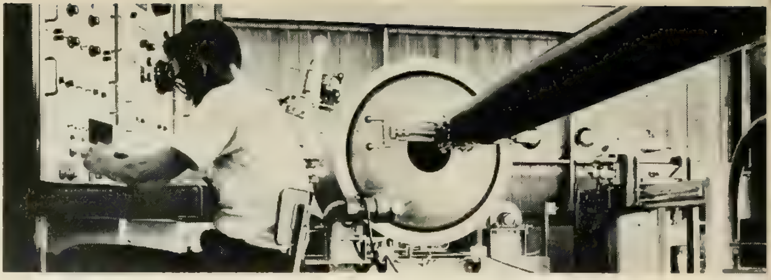


CEBM BOOM about to enter Polaris motor case at start of test procedure.

• **Microwave**—This system measures the effective dielectric constant of the case material to detect voids, delaminations or bubbles—all of which cause structural failure under load.

The microwave signals are generated by an oscillator, directed by a wave guide and sent through the material to a passive reflector mounted on a boom inside the case. A flaw causes a change in the amplitude or phase of the reflected wave. The signal is then processed through a filter and recorded.

• **Corona**—This system backs up the microwave assembly in that it detects voids and de-lamination that might not be picked up by microwaves.

The case wall is subjected to an intense electric field as it passes between high-voltage electrodes. Any gas trapped in a bubble or void ionizes as it passes through the field—causing a pulse of corona current which is read out on the small strip-chart recorder. Electronic filtering circuits are used with this system to eliminate background noise while amplifying the signal.

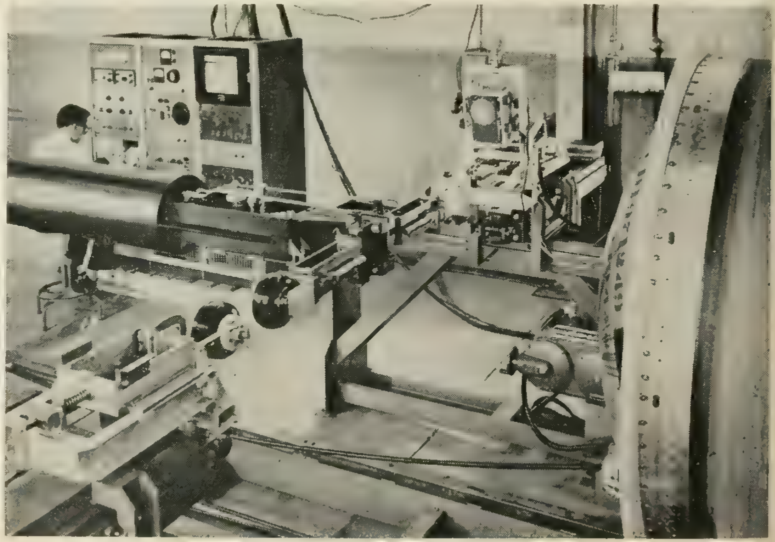
Small neoprene wheels, filled with a fluorocarbon oil, press against the case from both sides. The electrodes are within the wheels, and the whole setup is aimed at causing a corona flash only within the case wall.

• **Eddy current**—This portion of the test is conducted with a hand-held probe directed toward the rubber core within the case's end closures. The insulation thickness is read directly on a drum dial of the electronic unit.

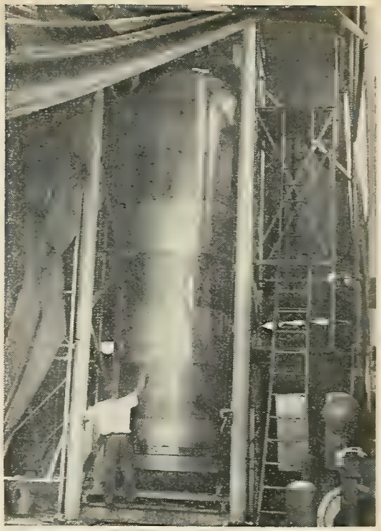
The Magnaflux unit also has three automatic defect-marking devices associated with each inspection technique. If a defect is found by either the beta-ray, microwave or corona systems, an alarm sounds. The exact spot is also marked with colored chalk.

Two facsimile recorders provide the test engineer with a complete record of the test—radar-like pictures of all defects.

While the CEBM system was tailored specifically for the *Polaris*, Magnaflux intends to market the device in other non-metallic product areas. Magnaflux had been developing the concept for about six months when Aerojet funded a feasibility program with the firm. The delivery of the system to Aerojet came within 18 months of the initial contract. ■



CLOSE-UP OF CEBM test equipment clearly shows the three automatic test stations. Neoprene wheels contain the corona discharge electrodes.



'Barrel Staves' Likely For Big Booster Cases

COMPLETED MODULAR filament-wound case with circumferentially wound hoops slipped over longitudinal modules and adhesively bonded.

FILAMENT-WOUND plastic rocket-motor cases—fabricated from high-strength longitudinal sections over 18 ft. long—may be the key to the extremely large booster cases needed in the future, according to the H. I. Thompson Fiber Glass Co.'s Research and Development Division.

Company spokesmen state that the new winding and joining process makes it possible to produce modular rocket-motor cases up to 20-30 ft. in diameter with all of the features of homogeneously wound cases—if the necessary tooling is acquired.

Present facilities for modular winding in the company's Gardena, Calif. plant can handle cases the same size as the first stage of *Minuteman*. With slight modifications, their large-swing/long-bed lathes could be adapted readily for winding sections for cases up to 14 ft. in diameter and 70 ft. long. Modular filament-wound cases require unique winding techniques but can be produced with comparatively low-cost tooling.

- **Barrel staves**—The plastic motor-case concept is a radical departure from conventional filament-wound plastic motor chambers. Instead of an integrally wound structure, filament-wound glass fiber sections are wrapped on a mandrel and cured. Longitudinal sections are fitted together like barrel staves to form the full-case diameter. They are held in place securely by filament-wound hoop rings, adhesive-bonded to the modules.

The aft closure is a separate detail attached to the cylindrical case by a bolted joint. The forward closure is an integral part of the filament-wound modules and is retained by a special steel fitting. The mechanical joint devised for the aft closure can also be used in any segmented case design, for it can just as easily join two cylinders as a cylinder and a closure.

The modular winding technique for large rocket-motor cases has been under investigation for several years because of the many inherent advantages of filament-wound plastic components—relative economy, light weight, high strength, short production lead-time, and high production rates with production-line assembly and quality control.

On the basis of reliability alone, say HITCO experts, sectionalized rocket-motor cases may expand the use of filament-wound plastics for major aerospace booster programs. An individual segment damaged in transit or otherwise defective obviously can be replaced more economically than having to scrap an entire filament-wound case.

- **Test results**—To date, two 18-in.-dia. by 60-in.-long subscale cases and one 65-in.-dia. full-scale case have been hydrostatic-tested to failure by HITCO. Both subscale cases performed successfully, exhibiting burst pressures of 1,595 psi and 1,800 psi, and total wall-circumferential stresses of 115,000 psi and 129,000 psi with EHTS glass. Fabrication difficulties were experienced on the module assembly of the 65-in.-dia. case, which failed in the module closure at a lower pressure than expected. These difficulties have now been solved, says HITCO.

Case modules are wound on a non-collapsible mandrel to which a thin elastomeric liner has first been applied. This liner becomes integrally bonded to the modules after cure and serves to eliminate possible leakage in both the longitudinal and hoop fibers during case pressurization.

Glass filaments are wrapped in a tube-longitudinal direction at a 0° winding angle. This configuration ensures fiber wrapping parallel to the axis of the motor case and the basic longitudinal stresses. Individual hoops are filament-wound on similar mandrels, and the hoop length can be tailored to conform to the full cylindrical section of the case itself. Fibers in both modules and hoops are oriented in the direction of primary stress loads to eliminate fiber crossovers.

High-strength forward and aft joint assemblies are produced by inter-leaving 300,000-psi stainless-steel foil between the layers of fibers during winding. These adhesive-primed foil layers are bonded to the wound unit, and their purpose is to reduce stress loads in the straight glass fibers. This joint concept is said to permit stress levels in the fibers in the 300,000 psi range, or practically the ultimate strength of the fibers in tension.

Modular filament-wound motor cases can be assembled either vertically or horizontally, although the former way is preferred by HITCO. Prior to assembly, forward and aft ends of individual wound sections are pre-drilled in jigs. The aft closure is placed in a fixture and the sections are attached to it with steel pins. The forward contoured ends of the modules are placed around the pre-drilled steel fitting and attached to it with heat-treated steel bolts.

With the forward and aft ends firmly secured, the filament-wound hoops are coated with an epoxy adhesive and slid over the modules to their proper locations. About 10 psi of air pressure is applied internally to force the modules out to the hoops. The adhesive is oven-cured, but for field assembly it can be modified for ambient temperature curing. ■

AWARDS

AIR FORCE

$4,100,000—**FMC Corp., Inorganic Chemicals Div.,** Baltimore, Md., for the production of unsymmetrical dimethyl hydrazine (UDMH) for use in rocket vehicles.

$2,500,000—**Atlantic Research Corp.,** Alexandria, Va., for an exploratory development program to demonstrate advanced technology in a very high performance solid rocket motor.

$550,000—**Electronics Engineering Co. of California,** Santa Ana, for elements of the Gulf Test Range Electromagnetic Test and Evaluation Data System (EMTED).

$440,000—**Sylvania Electric Products, Inc.,** New York City, for maintenance and operation of underground communications networks linking 22 missile sites in the U.S. Work will be performed at Schilling AFB, Salina, Kan., and Warren AFB, Cheyenne, Wyo.

$58,435—**Electronic Communications, Inc., Research Div.,** Timonium, Md., for an investigation of dynamic programming techniques in the design of large array antennas with unequal spacing between elements.

$49,270—**Rocket Research Corp.,** Seattle, for a research program on hypergolic ignition of gaseous rocket propellants.

North American Aviation, Inc., Atomics International, Canoga Park, Calif., for a study on the generation of electricity directly from atomic energy (undisclosed amount).

General Motors Corp., Delco Radio Div., Kokomo, Ind., for development of non-destructive techniques for reliability screening of transistors (undisclosed amount).

ARMY

$13,400,000—**Hercules Powder Co.,** Wilmington, Del., for propellants and explosives.

$5,500,000—**Radiation, Inc.,** Melbourne, Fla., for electronic equipment.

$4,100,000—**Thiokol Chemical Corp.,** Bristol, Pa., for rocket motors for *Sergeant, Pershing* and *Nike-Hercules* missiles.

$2,200,000—**Raytheon Co.,** Lexington, Mass., for *Hawk* missile system batteries.

$1,100,000—**Systems Development Corp.,** Watertown, Mass., for a training program for air defense systems.

$420,000—**Ryan Aeronautical Co.,** San Diego, Calif., for target guided missile model 124E.

$370,000—**Ling-Temco-Vought,** Dallas, Tex., for shell bodies for *Davy Crocket* surface-to-surface projectiles.

Giannini Controls Corp., Astromechanics Research Div., Berwyn, Pa., for development of fluid state flight control systems capable of withstanding the environments of the next generation of tactical space vehicles (undisclosed amount).

NAVY

$127,000,000—**General Dynamics Corp., Electric Boat Div.,** Groton, Conn., for construction of three *Polaris* submarines.

$90,600,000—**Newport News Shipbuilding and Drydock Co.,** Newport News, Va., for construction of two *Polaris* submarines.

$6,600,000—**Sanders Associates, Inc.,** Nashua, N.H., for research and development on electronics equipment.

$5,700,00—**Thiokol Chemical Corp.,** Denville, N.J., for production of LR62-RM-2 *Bullpup* engines.

$5,600,000—**Northern Ordnance, Inc.,** Fridley, Minn., for continued production of *Terrier* missile launching systems.

$5,100,000—**Notrhern Ordnance, Inc.,** Minneapolis, Minn., for MK 13 Mod 0 guided missile launching system.

$3,600,000—**General Dynamics Corp., Pomona, Calif., Div.,** for preproduction engineering during the research and development phase of the *Mauler* system.

$1,800,000—**Raytheon Co.,** Lexington, Mass., for *Sparrow III* production.

$1,200,000—**Texas Instruments, Inc.,** Dallas, for engineering services on the *Shrike* system.

$1,100,000—**Consolidated Electrodynamics Corp.,** Monrovia, Calif., for work on a classified project.

$928,000—**General Dynamics Corp., Convair/Daingerfield,** Daingerfield, Tex., for research and development to operate ordnance aerophysics laboratory in conjunction with *Talos* testing. Work to be performed at Lone Star, Tex.

$741,473—**Thiokol Chemical Corp., Reaction Motors Div.,** Denville, N.J., for research and development on liquid propellants.

$723,098—**Hicks Corp.,** Asheville, N.C., for production of rocket motor MK 37 Mod 0 (inert) for *Asroc* missiles.

$694,725—**Minneapolis-Honeywell Regulator Co., Ordnance Div.,** Hopkins, Minn., for airframe MK 4 Mod 0 for *Asroc* missile.

$595,000—**Aerojet-General Corp.,** Azusa, Calif., for evaluation of high energy materials as liquid propellants.

$469,691—**Loral Electronics Corp.,** New York City, for research and development on air-to-surface missile detection and classification system.

$420,000—**Control Data Corp.,** Minneapolis, Minn. for research and development related to *Talos* weapons system dynamic performance requirements.

$404,213—**United Aircraft Corp., United Technology Center Div.,** Sunnyvale, Calif., for research on hybrid propulsion.

$399,500—**Raytheon Co.,** Lexington, Mass., for studies, analysis and design changes in the AAM-N-6b *Sparrow III* missile.

$357,974—**RMF, Inc.,** King of Prussia, Pa., for *Bullpup* missile nose section containers.

$299,750—**Aerojet-General Corp.,** Sacramento, Calif., for research in improvement program for hybrid engines.

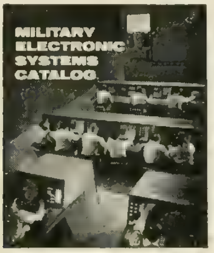
$275,000—**General Dynamics Corp., Pomona, Calif., Div.,** for services on *Terrier* and *Tarar* missiles.

$256,832—**General Dynamics Corp., Pomona, Calif., Div.,** for research, development, technology and engineering on the *Redeye* missile system.

$246,746—**Atlantic Research Corp.,** Alexandria, Va., for production of *Arcas* sounding rockets.

$182,006—**Chance-Vought Corp.,** Dallas, Tex., for research and development on the Slam (LASV) low altitude supersonic vehicle for the Air Force.

$112,865—**Minneapolis-Honeywell Regulator Co., Ordnance Div.,** Minneapolis, for *Asroc* engineering support.



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$98,110—United Aircraft Corp., East Hartford, Conn., for ultrasonic light scanning techniques for application to active target imaging systems.

$39,449—National Beryllia Corp., Haskell, N.J., for development, fabrication and evaluation of beryllium oxide fibers.

NASA

$9,204,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., for continuation of the RIFT (Reactor in Flight Test) Program through 6-26-64.

$478,922—State University of Iowa, Iowa City, Iowa, for an *Injun-Explorer* spacecraft.

$320,000—Republic Aviation Corp., Farmingdale, N.Y., for development of a "magnetic hammer" for shaping *Saturn* booster rocket sections, manufacturing techniques and space hardware (four contracts).

$129,315—Hughes Aircraft Co., Culver City, Calif., for a study of flight display and control integration for manned space flight.

$124,000—Chance-Vought Astronautics Div., Dallas, for a study aimed at determining the best possible crew station displays and controls for manned interplanetary spacecraft and other advanced vehicles beyond the *Apollo* lunar program.

$100,000—Republic Aviation Corp., Farmingdale, N.Y., for a study of bio-medical and human factors requirements for a manned earth orbiting station.

$94,829—Wyle Laboratories, Huntsville, Ala., for a study of the effects of clustered large solid engines on structural vibration levels.

$87,300—Space Technology Laboratories, Inc., Redondo, Beach, Calif., for a study of the effects of X-258 on the *Pioneer* solar spacecraft.

$84,108—Boeing Co., Seattle, Wash., for an investigation of vehicle-integrated rocket powerplants with air augmentation.

$46,515—Martin Marietta Corp., Denver Div., for a study of geysering cryogenics.

$30,000—Ling-Temco-Vought, Inc., Dallas, for emergency repairs of launch equipment at the Pacific Missile Range, Point Mugu, Calif.

Martin Co., Baltimore, for continued processing of data transmitted by the *Orbiting Solar Observatory* satellite (undisclosed amount).

INDUSTRY

$7,000,000—Northrop Corp., Nortronics Div., Palos Verdes, Calif., from the **Boeing Co.,** for production of additional voice reporting systems to equip *Minuteman* missile launch silos.

$3,200,000—Avco Corp., Lycoming Div., Stratford, Conn., from **Aerojet-General,** for titanium chambers and closures for *Minuteman* second stage motors.

$1,200,000—Sverdrup and Parcel and Associates, Inc., St. Louis, Mo., from **Aerojet-General Corp.,** for design and support services assistance on instrumentation and controls for NASA's Mississippi test facility.

$768,000—General Dynamics Corp., Convair Div., San Diego, from **North American Aviation,** for fabrication of additional guidance housing assemblies for the *Minuteman* missile.

$760,000—American Potash and Chemical Corp., Henderson, Nev., from **Aerojet-General Corp.,** for ammonium perchlorate for use in solid rocket development.

$223,287—Baldwin-Lima-Hamilton Corp., Waltham, Mass., from the **Martin Co.,** for pressure transducers to be used in *Titan III*.

$100,000—Dresser Electronics, H.S.T. Div., Garland, Tex., from **Boeing Co.,** for transformers for use in the *Minuteman* weapon system.

$75,000—Mississippi Valley Helicopters, Inc., Knob Knoster, Mo., from **Boeing Co.,** for helicopter rental services for use in the *Minuteman* program in the Knob Knoster area.

Minneapolis-Honeywell Regulator Co., Minneapolis, from **Martin Orlando,** for construction of autopilot inertial components for one part of the guidance system of the *Sprint* weapon system (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Lewis Research Center
21000 Brookpart Road
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Service and material to design and manufacture one argon gas cooler. Work consists of all engineering labor services, equipment and materials for the design, fabrication, testing and delivery of a two-stage argon gas cooler and auxiliary equipment. Outlet temperature and pressure of the argon gas after cooling are critical. The quality of workmanship and delivery are very critical. IFB C-105011. Bid opening 8-23-63.

Service, labor and material necessary to furnish and install a hybrid computer system consisting of a high-speed general purpose digital computer and control and data linkage equipment assembled into a fully integrated and operational system. This system will be tied in with the Lewis Research Center's present analog computer equipment. RFP C-103142. Copies will be furnished on a first received first served basis to the extent available. Call NASA, Cleveland, Ohio, Code 216, 252-7700, Ext. 533. RFP due date 9-12-63.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and material necessary to fabricate three ignition battery simulators and provide connecting cables for conducting *Scout* vehicle ignition tests in accordance with NASA drawings. Job—IFB L-3478. Bid opening 8-20-63.

Lewis Research Center
21000 Brookpart Road
Cleveland, Ohio

Services and materials necessary to furnish and deliver heat exchangers in accordance with NASA, Lewis Research Center specs. Delivery to NASA, Cleveland, Ohio. For bid form request, phone NASA, Code 216, 252-7700, Ext. 525. Copies will be furnished on a first received first served basis to the extent available. IFB C-97052. Bid opening 8-19-63.

Atlas Procurement Div.
Missile and Propulsion Branch
Norton AFB, Calif.

Production list 04-607-64-05 is being procured against contract AF-04 (607)-8052 for replinishment spare parts. It is suggested that small business firms and other interested in subcontracting opportunities in connection with this procurement make direct contact with Rocketdyne Div., North American Aviation, Inc., 6633 Canoga Avenue, Canoga Park, Calif.

PROJECT: F-111 and other Aerospace Programs

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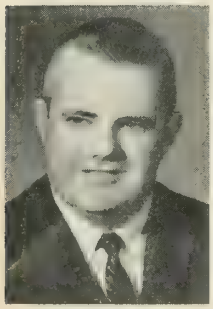
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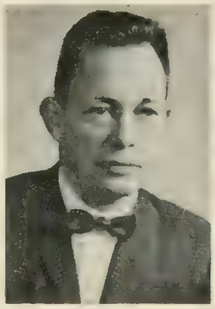
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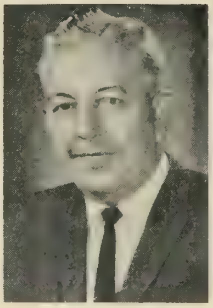
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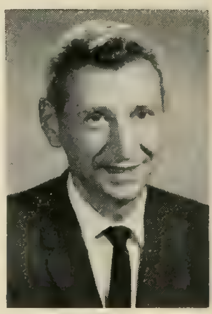
KORELITZ

Thomas J. Sullivan: Elected president and board chairman of Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla.

Maurice A. Sulkin: Named assistant to the vice president of research and development at North American Aviation's Los Angeles division.

Eugene S. Culver: Elected president of Washington Technological Associates, Rockville, Md.

J. Tom Maidens: Promoted to director of marketing for Scully-Jones and Co., Chicago.

Milton B. Korelitz: Named general manager, eastern operation of Studebaker Corp.'s CTL Missile/Space Technology Div., Cincinnati.

Frederick B. Martin, Jr.: Named director of business development for Space Systems Div. of Fairchild Stratos Corp., Washington, D.C.

Dr. Daniel C. Schiavone: Named director of reliability, test and evaluation at Martin Co.'s Orlando, Fla., Div.

Karl Philippi: Named executive vice president of Tempel Steel Co., Chicago.

K. C. Christiansen: Appointed divisional controller for Air Reduction Sales Co., New York City.

Rees P. White: Named marketing manager-electronic countermeasures and antisubmarine warfare techniques and systems at Sylvania Electronic Systems Div. of Sylvania Electric Products Inc., Buffalo, N.Y.

Howard R. Bartholomew: Appointed West Coast regional manager-military products for the General Time Corp., Los Angeles.

J. R. "Bob" Willson: Appointed director of industrial relations at Page Communications Engineers, Inc., Washington, D.C.

Ronald E. Jachowski: Appointed manager of applications engineering for instrumentation products at Motorola Instrumentation and Control Inc., Phoenix, Ariz.

Donald L. Repe: Controller of Doughboy Industries, New Richmond, Wis., named a vice president.

Julian R. Levine: Former public relations director for Martin Co.'s electronic systems and product division, named Washington, D.C. public relations director for Aerojet-General Corp.

Dr. Charles E. Duke: Named executive vice president at HRB-Singer, Inc., State College, Pa. **Capt. J. S. Holtwick** (USN ret.) elected vice president-administration and management services. **Philip J. Freed** named vice president and treasurer; **Wayne A. Burnett** named technical director and **Dr. Elton S. Carter** appointed director of professional development.

Dr. Milton U. Clauser and Dr. J. P. Ruina: Former vice president of Space Technology Laboratories and professor of electrical engineering at MIT, respectively, joined Communications Satellite Corp., Washington, D.C., as full time consultants.

Henry J. Bopp, Jr.: Appointed field liaison manager at Victory Electronics, Inc., Syosset, L.I., N.Y.

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AUGUST

AIAA Guidance and Control Conference, Massachusetts Institute of Technology, Cambridge, Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, sponsored by AIAA and Northwestern University, Evanston, Ill., Aug. 14-16.

Electronic Circuit Packaging Symposium, sponsored by University of Colorado, *Electrical Design News* **and** *Design News,* University of Colorado, Boulder, Aug. 14-16.

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Cryogenic Engineering Conference, sponsored by NBS and Cryogenic Engineering Laboratory and University of Colorado, Boulder, Aug. 19-21.

1963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creek, Wis., plant, Aug. 23.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries Seminar, sponsored by the Contract Management Institute, Clift Hotel, San Francisco, Aug. 26-30.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

Open Space and Peace Symposium, sponsored by the Hoover Institution on War, Revolution and Peace and Stanford University, Stanford, Calif., Sept. 4-6.

Symposium on the Ellipsometer and Its Use in the Measurement of Surfaces and Thin Films, National Bureau of Standards, Washington, Sept. 5-6.

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

National Symposium on Space Rendezvous, Rescue and Recovery, sponsored by American Astronautical Society and Air Force Flight Test Center, Edwards Air Force Base, Calif., Sept. 10-12.

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Surveying Surveyor

THE EFFORT of the National Aeronautics and Space Administration to support both a manned and unmanned exploration of the Moon is a costly one for the nation.

Under the requirements laid out by NASA, the *Surveyor Lander* and *Orbiter* programs are seeking purely scientific data—data that will be obtained later by the *Apollo* program—when *Surveyor* should be oriented only to supporting the *Apollo* mission.

Take a look at the way NASA officially describes the *Lander* program:

"Once safely down on the lunar surface, the *Lander* will serve as a remote observation post for surveying the lunar topography and examining the surface texture. It will also function as a stationary laboratory for measuring the physical and chemical characteristics of the lunar surface and subsurface, and the environmental conditions on the Moon. Typical of the data to be obtained by *Surveyor* are high-resolution television pictures of the terrain in the vicinity of the landing site, measurements of the lunar surface hardness and other physical characteristics, its chemical and mineralogical composition, seismic activity and the rate of meteorite particles striking the Moon."

And at this point, NASA discloses the fuzzy thinking that has plagued the project: "In addition to its scientific function as a lunar research laboratory, the *Lander* will provide essential data in support of the *Apollo* manned lunar landing program."

Why in thunderation should *Surveyor* have been designed for any other function than supporting the *Apollo* manned landing program? Why is it being designed as a complex remote laboratory when man himself will shortly be along to do the job in person? Why is provision of data for *Apollo* described as a mere *addition* to its scientific function?

The attempt to obtain scientific data other than those which contribute directly to the *Apollo* mission needlessly complicates the project. Let men perform the scientific functions when they get there. Let *Surveyor* contribute to getting them there.

Is it essential to the *Apollo* mission that a chemical analysis of the lunar subsurface soil be obtained? Do *Apollo* designers have to know the heat conductance of the lunar soil? Will the television cameras contribute necessary data that will not be obtained in other ways prior to the lunar landing?

The answer to some of these and like questions may be yes. But the question of contribution to *Apollo* should have been asked in regard to every single *Surveyor* requirement.

There are parameters we must know: Can the lunar surface support the lunar module? Penetrometer experiments will provide the answer. Are there radiation or meteorite bombardments that could jeopardize the astronauts? Simple condenser impact instruments or counters can supply the data. Is the terrain hilly or flat? The attitude of the *Surveyor* spacecraft itself will provide part of the answer.

Surveyor should have been designed as simply as possible to provide data needed for input to *Apollo*. This would have reduced its weight and speeded its timetable. *Apollo* design data is needed as soon as possible. The complexity required for *Surveyor* by NASA is slowing acquisition of that data.

The booster for *Surveyor Lander* is to be *Atlas-Centaur,* capable of thrusting 2,300 lbs. to escape velocity. By making fewer demands, might it not have been possible to design a lighter-weight spacecraft for *Atlas-Agena,* which can hurtle 750 lbs. to escape? *Atlas-Agena* is ready today; *Atlas-Centaur* is not.

There is also the extremely reliable *Thor-Delta,* capable of boosting 140 lbs. out of orbit. We wonder just how much of the data really vital to *Apollo* design could be obtained with a 140-lb. package sent to the lunar surface.

Might it not be better to send many lightweight *Surveyors* onto the lunar surface with *Thor-Delta* or *Atlas-Agena* to get a fair sampling, rather than just a few with *Centaur*?

Imagine the problems of trying to design a craft to land men on Earth by using the remote input of only a few Earth-probing *Surveyors*—if one landed in the ocean, one in the Sahara, one in New York City and one in a tree.

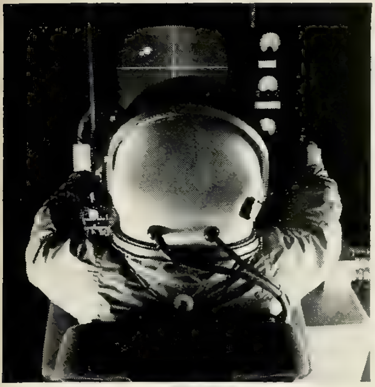
WE DON'T BRING all this up to suggest that a complete reorientation of *Surveyor* is desirable or possible at this point. NASA put $35,629,000 into the *Surveyor Lander* spacecraft in Fiscal 1962, $48,296,000 in Fiscal 1963. The FY '64 budget calls for authorization of $37,500,000 for the *Lander* craft alone—with another $18 million for *Orbiter* and $42 million for launch vehicles.

This is a sizeable investment and we believe much of it may be waste—merely because NASA has been program-oriented in this regard rather than mission-oriented, trying to support both a manned and unmanned exploration rather than a single mission.

If man is going to explore the Moon, it is not necessary to develop an unmanned spacecraft to do the same job. The money and effort for unmanned scientific spacecraft should be saved for missions to planets such as Mars and Venus where man will not set foot for many, many years.

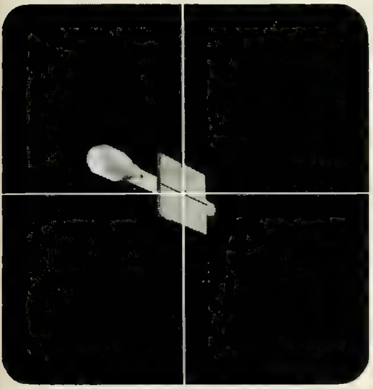
Now that we have established a manned lunar landing in this decade as a national goal, unmanned spacecraft bound there should be designed solely to contribute to that mission. It is too late to redesign *Surveyor.* But it is not too late to simplify it, nor is it too late to ask whether both *Lander* and *Orbiter* are necessary to Apollo.

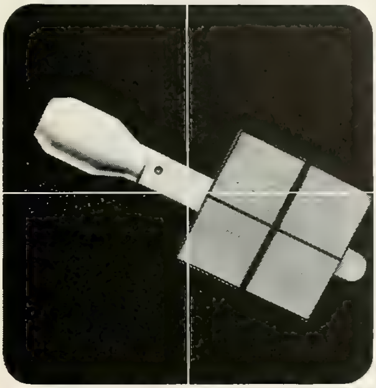
William J. Coughlin


Rendezvous with space station

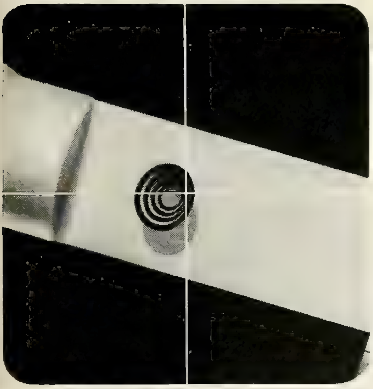
Range 2,000 feet, closing velocity 20 f.p.s.

Aligning with solar panels and closing


Range 600 feet, aligned with solar cells . . .


Maneuvering for final alignment, velocity 3 f.p.s.

Translating toward docking port


Correcting left yaw and left roll, range 50 feet

Velocity 1 f.p.s., yaw 0, roll 0 — correcting pitch

Alignment aid shows all attitudes 0. Ready to latch.

Rendezvous in space

To investigate space rendezvous techniques, Boeing has developed a simulator capable of reproducing conditions involved in bringing two orbiting vehicles together in a docking mission.

Through a projected TV presentation, the pilot, shown in the "planetary exploration vehicle" cockpit above, sights his target vehicle. Using controls operating through a computer system, the pilot maneuvers his vehicle and completes his docking run.

The program is determining space station and shuttle vehicle design requirements, types of docking mechanisms, impact conditions and energy absorbing requirements.

Backed by the most extensive facilities in industry, Aero-Space Division's scientists, engineers and technicians are achieving technological advances in a wide spectrum of areas, including space medicine, guidance, electronics, vehicle design, lunar base requirements and life support systems and equipment.

These advanced capabilities, plus experience in depth in the management of vast, complex systems, equip Boeing to make major contributions to the nation's progress in launch systems, space travel, planetary landing programs, and space rendezvous and logistics missions.

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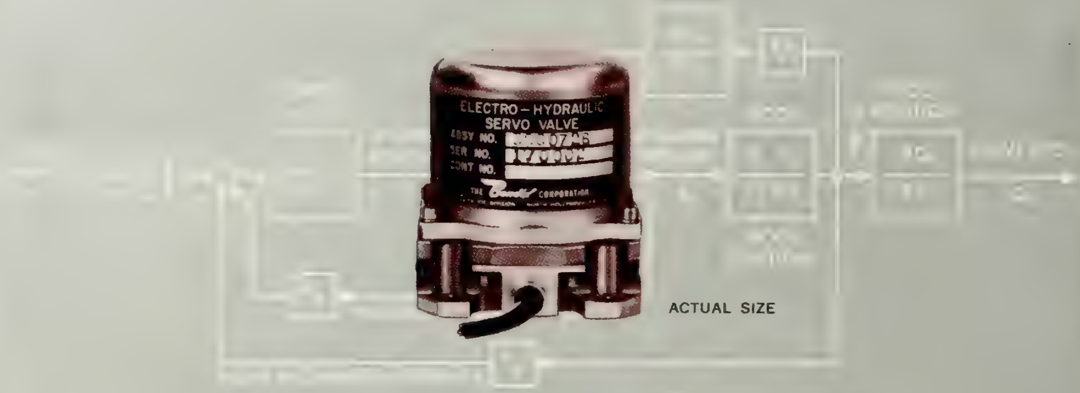

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Write Bendix-Pacific, North Hollywood, California for Technical Bulletin 66325.

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AUGUST 19, 1963

missiles and rockets

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Air Force Troposcatter Array in Spain

U.S. Presses Vela Hotel Development .
Dyna-Soar Project Picks Up Momentu
Westinghouse Outlines Gemini Radar

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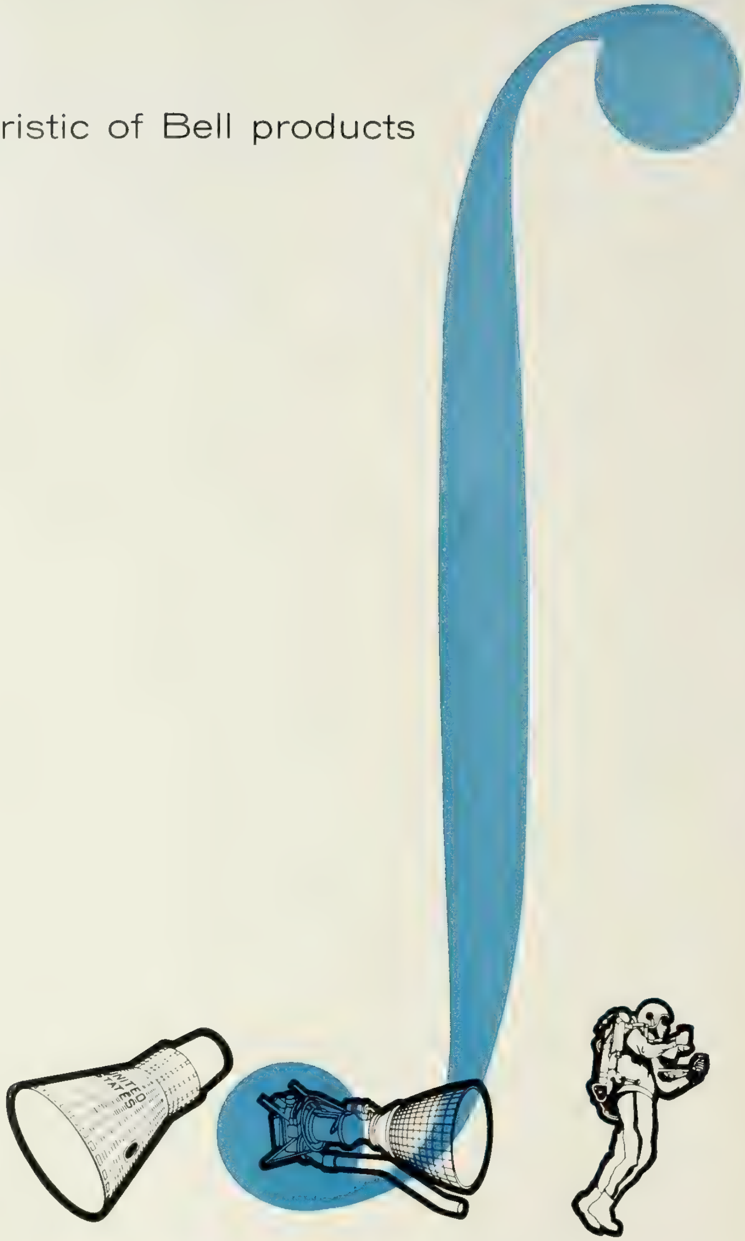
Integral characteristic of Bell products



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DIVISION OF BELL AEROSPACE CORPORATION-A Textron COMPANY

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FROM SOLAR COMPASS TO AVIONICS

Solar Compass (American-1836)—Used to indicate the direction of true north by a single observation of the sun's position. A similar device was used in 1926 by Adm. Richard E. Byrd on his historic flight over the South Pole, an area where anomalies render the magnetic compass inaccurate. (Dossin Museum)

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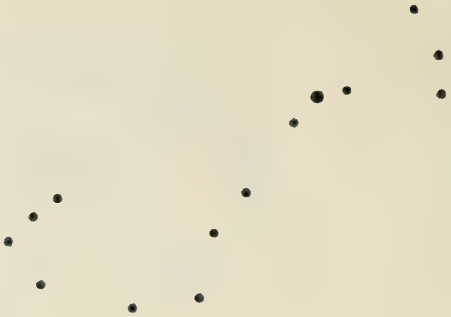

Guidepost

The constellation Scorpio is one of the most familiar sights in space. When many problems of guidance are solved, it could well become an important guidepost for astronauts during their journey to the moon.

Guidance sensitivity is one of the most critical areas of America's manned space flight program. What precise point in space is best for mid-course maneuvering? What are the references, the guideposts for such maneuvers? How much energy should be expended for a correction at any given time?

Bellcomm is now at work analyzing many of these problems, searching for unknowns that could affect guidance in the mysterious reaches of space. It is part of the total job Bellcomm is doing for NASA, planning and evaluating manned flight systems.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

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THE COVER

Troposcatter antenna array near Humosa, Spain, designed and installed by Northrop Corp.'s Page Communications Engineers, is one of a group of stations providing multi-channel voice and teletype service for AF in Europe.

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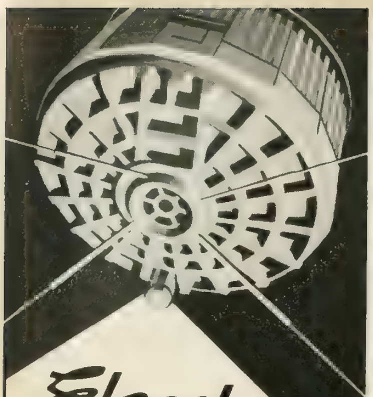

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letters

State of the Union

To the Editor:

In answer to your July 22 editorial:

Thank God there are men like you and your staff in this world. Please keep up your good work.

L. D. Coffman
Kirk Eng. Co.
Los Angeles

To the Editor:

The issue you raise is an important one and it needs all the push behind it that can be obtained. The Civil Air Patrol is a pioneer in this space education business, having established an aerospace workshop in the Puerto Rican Wing in 1953. These workshops are for teachers, who can take what they learned back to their own schools. Today, we are sponsoring one hundred and fifty of these workshops in universities across the Nation.

I have been addressing Kiwanis, Lions and Rotary in Wisconsin on the importance of our space program for the past five years. These people are interested and receptive. The comment I hear EVERY time is that "you could hear a pin drop while the Colonel was talking."

Still, there is a disturbing apathy on the part of the public to support our program and it worries me, as I see our Country slipping down the drain. I heartily concur with your editorial, except in one respect. You say you don't think it is necessary to go to the extremes you suggest. I think they are necessary.

I have just returned from making the closing address at a C.A.P./USAF-sponsored workshop at Miami University, Oxford, Ohio. This particular workshop has been operating for eleven years, but there is an effort by conservatives of the faculty to torpedo the program on the grounds that our space program is not worth the money being spent on it.

During a panel discussion with members of the faculty, I took the liberty of quoting from your previous editorial in this respect. I think I convinced those present of the importance of these workshop.

At a C.A.P. Wing Commander's meeting in Cincinnati last Friday evening, an item on the agenda was how to approach aerospace education in our school systems. The Wing Commanders from Ohio, Michigan, Indiana, Kentucky, Illinois and Wisconsin all dwelt on the same theme—the apathy and resistance encountered when we approach school superintendents on this subject. Believe me, I speak from experience when I say it's terrific.

In closing, I would like your permission to use portions of your fine editorials to bolster our case in the future.

R. J. Bassett
Lt. Col., Civil Air Patrol
Deputy for Aerospace Education
Manitowoc, Wis.

Permission granted.—Ed.

Astronaut Geriatrics

To the Editor:

As the space program expands, many projects of sophisticated nature progress. An important area of life sciences, however, seems to be completely overlooked. The most important mechanism in extended space missions will be man himself. Man is the longest-lived trouble-free component of any system yet designed and constructed. The present method of ensuring reliability of the human is to select—i.e., only the best physical specimens are employed. Indications are that the deterioration of man (aging) may be reversible, or at least arrestable, process. It would seem that if a human could be kept from aging, his reliability as a component in a space system would be substantially increased. A sizeable program to investigate the properties of aging in human and methods of controlling the same should be in the works at NASA. Surely the public would support a program with such intriguing possible civilian fallout.

Henry Oswald, President
Celestron Associates
Yonkers, N. Y.

What Astronauts See

To the Editor:

Thoughts on what an astronaut can or cannot see on the Earth from orbit:

I know from personal experience that from the vicinity of 100 miles away (on the ground) from Pike's Peak, it is possible to see the building on top of the mountain. This is looking through air all the way, but since the atmosphere thins out to practically nothing by an altitude of about 100,000 ft.—say 20 miles, an astronaut looking down from orbit would be looking through only about 20% as much atmosphere, with consequently less distortion of light rays. The present ideas about resolving power of the eye may be true "on the ground," but untrue under vacuum (space) conditions. It might also be affected by weightlessness. Then again, it might just be the trained observing eye, contrasted with an ordinary eye.

At any rate, I feel we should investigate, rather than arbitrarily assign the label "hallucination" to what Astronaut Cooper reported during his flight.

Earl W. Gault
Los Altos, Calif.

To the Editor:

Re M/R, July 8, p. 21, covering astronauts' statements that they could see small objects on the Earth's surface, and Dr. W. R. Adey's doubts as to such visual acuity: could it be that both sides are correct—with the atmospheric density situation creating, under certain conditions, a giant lens effect?

C. F. Marschner
Marietta, Ga.

Checkout procedures on a newly manufactured space vehicle—its every component, subsystem and finally, complete system—have until recently been a monumental task. The complete performance of each item was recorded, then either processed and analyzed using entirely manual techniques, or run through computers, translated into digital language, and then manually interpreted and compared with predetermined optimum standards. Two to three weeks often elapsed before final approval could be given.

With the Lockheed-developed AUTO-DRAPE system—Automatic Data Recording and Processing Equipment—checkout time has been cut to a few days. The key to this time and labor saving system is simple: A "filter" device has been installed between the checkout signal and the analyst. AUTO-DRAPE thus produces an "exception" report—a printed tabulation of vehicle functions not performing within preassigned limits. This advanced technique—which makes use of a real time, on-line digital computer—eliminates the need to manually examine some 80% of the data.

With this system, engineers at Lockheed Missiles & Space Company are now able to process data at the amazing rate of *40 Kc in real time.* Based on these principles, Lockheed is also operating the VADE system, currently performing launch readiness functions at the Pacific Missile Range. A further extension of this concept is being developed to process the telemetered signals of a vehicle in flight.

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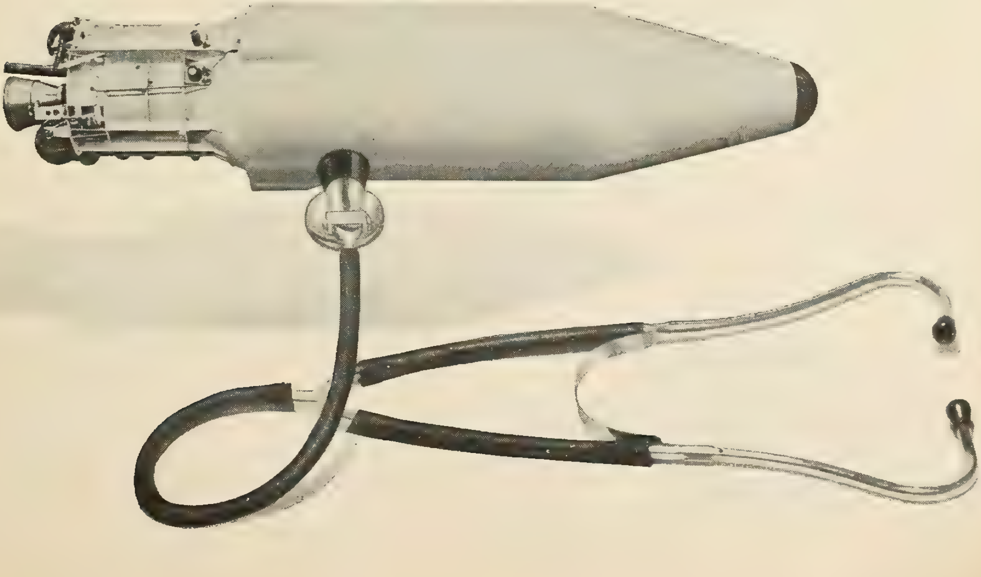
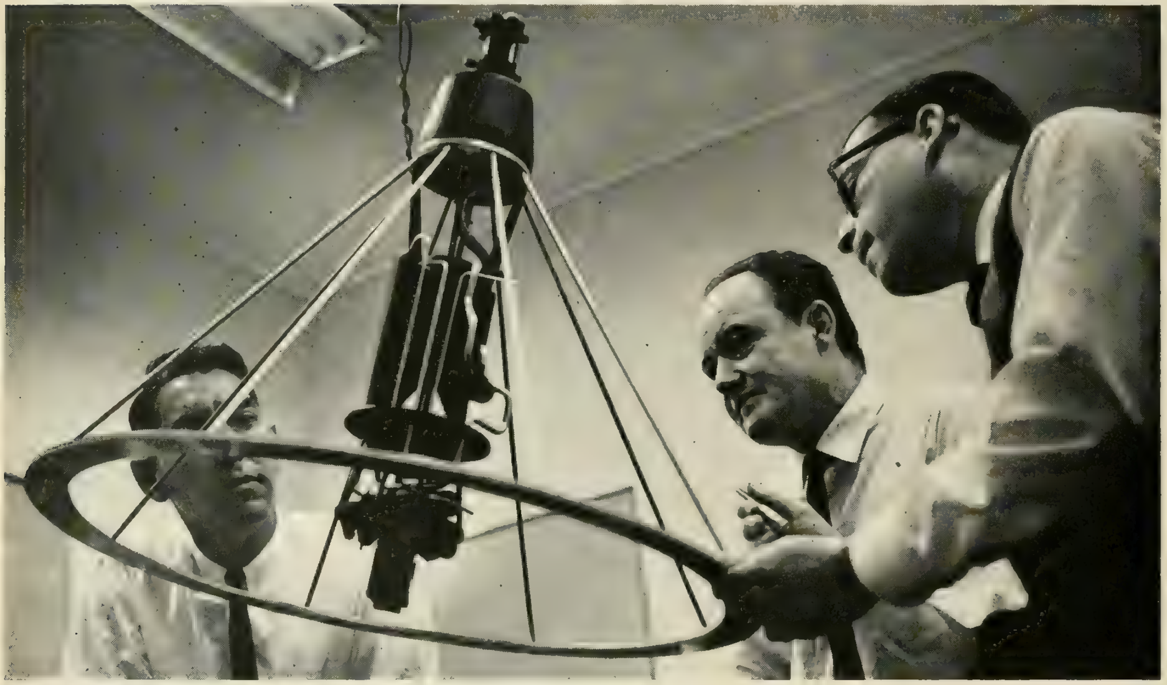


SNAP-8: vital in-space power

The SNAP-8 nuclear turbo-electric space power conversion system, under development for the National Aeronautics and Space Administration to provide 10,000 hours of continuous operation in space, is the kind of reliable, long-duration power that will become increasingly important in the ambitious years ahead as manned orbiting laboratories are launched...deep-space probes push off to such planets as Mars and Venus...permanent lunar bases are established.



SNAP-8 DIVISION outstanding space power opportunities

Immediate openings exist for experienced or recently graduated engineers with BS or MS degrees (particularly in mechanical, electrical, metallurgical, nuclear or aeronautical engineering) in the following areas...**NUCLEAR POWER SYSTEMS**: design and analysis of dynamic liquid metal systems, structural and thermal design. **SOLAR POWER SYSTEMS**: design and analysis of dynamic and static conversion systems, energy storage, absorbers, and concentrating devices. **ROTATING MACHINERY**: turbines, pumps, motors, seals and bearings. **HEAT EXCHANGERS**: liquid metal heat transfer, boiler and condenser design and development. **METALLURGY**: advanced liquid metal materials and systems technology, specialized welding, high temperature materials. **TESTING**: rotating components, environmental, liquid metals, nuclear systems, instrumentation.

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The Countdown

WASHINGTON

NASA, DOD Bills Await Congressional Action

With the government nearly two months into the new fiscal year, none of the major missile/space budgets have emerged with final Congressional sanction. NASA's authorization bill, in joint House-Senate conference, is expected to go to the appropriations committees in the next two weeks. Dept. of Defense budget, now lacking only Senate appropriation committee action, still is awaiting a call to order by subcommittee chairman Sen. Richard B. Russell (D-Ga.) He has been tied up by activity in the Senate Armed Services Committee, which he also chairs.

Space Station Funding Outlook Is Dim

Chances of hardware funding in the Fiscal '65 budget for a manned orbiting space station are fast disappearing. NASA Administrator James E. Webb and Secretary of Defense Robert S. McNamara still have not met to discuss the project. A top NASA official says it is unlikely the space agency will request funds for the station. Lack of Webb-McNamara interest in the subject is an indication that there will be no DOD funding either—since neither agency can initiate such a project without approval of the other. Funding requests for FY '65 must be submitted to the Bureau of Budget next month.

Joint Lunar Project Seen Unlikely

In an effort to clear up the muddied picture of Soviet intentions left by Sir Bernard Lovell, deputy NASA Administrator Dr. Hugh Dryden is writing to his Soviet counterpart in U.S.-USSR space cooperation talks, Academician A. A. Blagonravov, to sound out the Russian position on a joint lunar program (see p. 21). Any agreement is considered unlikely. The Soviets always have been opposed to such cooperation and high Kennedy Administration officials consider it unpractical.

BIOS Contractor Selection Is Near

Selection of a contractor for the *BIOS* biological satellite program is expected soon. NASA's source selection board on the project met recently but delayed a final decision due to absence of some of the top officials. Three firms are competing for the award: General Electric, Lockheed and Northrop.

Static Testing of S-IV to Continue

Saturn S-IV second stage will be static-tested by Douglas Aircraft for about six more weeks before shipment to Cape Canaveral. It is scheduled for launch on the *SA-5* booster in November or December. Two tests already have been held, one for one minute and the other for seven. Although both were labeled successful, the first was cut short due to a fire warning. Further checks disclosed, however, that the problem was not fire but an overly sensitive temperature detector.

First Little Joe II Launch Coming Up

First launch of the *Little Joe II* booster at White Sands, N.M., now is expected late this month or early in September. First off-the-pad abort test of the *Apollo* spacecraft escape system will be made about two weeks later.

Work on Saturn V Is Underway

Marshall Space Flight Center is beginning fabrication of a test fuel tank and the static test vehicle in the *Saturn V* program. First test firing is scheduled for the fall of next year. Meanwhile, the center is winding up its fabrication work on *Saturn I* with the assembly of the *SA-9* launch vehicle.

INDUSTRY

Aerojet Official Accepts NASA Post

The vice president and general manager of Aerojet-General's Sacramento, Calif., plant is joining NASA's Marshall Space Flight Center as director of projects and industry operations. Robert B. Young will fill a new position created to oversee the portion of Marshall's work carried out by industrial contractors.

Westinghouse to Study Navigation Satellite

Westinghouse has received a contract to study a civilian navigation satellite system for NASA. The contract calls for a program definition study which will analyze possible combinations of satellites, ground stations and user navigation aids to define a system for achieving the desired benefits at minimum cost.

Contract Let for Three Echo II Balloons

NASA has selected the G. T. Sohjeldahl Co. of Northfield, Minn., for a $362,000 contract to build three *Echo II* balloons. The contract, awarded by Goddard Space Flight Center, calls for launch from Pacific Missile Range late this year. The balloon, made of more rigid laminated mylar plastic and aluminum, is 35 ft. larger in diameter than the 100-ft.-dia. *Echo I*. One of the three balloons will be used for static test and another as backup for the flight vehicle.

Douglas Sets Up Marshall Support Group

Douglas Aircraft has established a Technical Support Group at Marshall Space Flight Center to provide engineering assistance for the Douglas-built S-IV and S-IV B *Saturn* stages. Manager is W. F. Shaver.

Photo Instrumentation Demands Increase

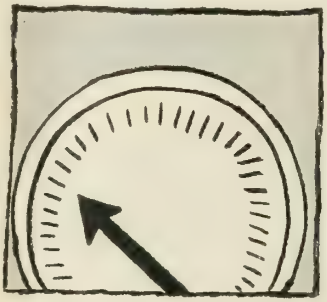
Nothing less than 100% reliability in photographic instrumentation will be acceptable as manned spacecraft programs intensify, Brig. Gen. Joseph J. Cody Jr., vice commander, Space Systems Division warned the Society of Photographic Instrumentation Engineers in Los Angeles. He called for continuing improvements in color emulsion, in focal length range and in development of ways to obtain more data via photo instrumentation.

INTERNATIONAL

UK-3 Subcontract Awards Due Shortly

Subcontracts for instrumentation of the *UK-3* satellite are to be placed with British electronics firms within the next few months by British Aircraft Corp. Five onboard experiments for the all-British satellite have been selected and now are being definitized.

How much Micro-Impact on Hoover Dam?



Can you measure the change in current at Hoover Dam when a bulb blinks on in L.A.? Tell the thickness of cigarette smoke? Detect an air leak that would take 10,675 years to inflate a volleyball?

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Advanced Radar Specialist: Perform H-port studies involving stochastic processes, including the analysis of high frequency receivers and techniques for application to atmospheric and space radar systems.

Systems Specialist: Responsible for the integration of inertial components, digital computer equipment, stellar monitoring, and radar equipment into a complete guidance system.

If you are ready to move ahead with one of the nation's top electronics organizations, send your resume now to Mr. K. H. Theibert, Professional Recruiting Services, Autonetics, Anaheim, California.

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The Missile/Space Week

Navy Balks at PMR Switch

Early reports to the contrary notwithstanding, the Navy is not happy with the recent suggestion by the Office of the Secretary of Defense that Pacific Missile Range management might better be turned over to the Air Force (M/R, Aug. 12, p. 12).

Range Commander Adm. John Clark intimated to M/R that the Navy would not object to the Air Force assuming complete control of the big booster facility at Point Arguello, but that the Navy should retain its stewardship of the overall range operation. He said the Navy believes that "in the national interest it would be a shame to fragment the range."

In fact, the Navy is not resigned to the idea it may lose control of PMR. Clark insists that "no official decision has been made," and that none will be made for some weeks.

STINGS Interest Continues

The stellar inertial guidance system (STINGS) planned for the now-defunct *Mobile Medium-Range Ballistic Missile (MMRBM)* apparently will be developed for future weapon systems—but it is temporarily stalled by lack of funding.

About $40 million in Air Force money went to General Precision, Inc., prime STINGS contractor, while the *MMRBM* program was alive. Cancellation of the missile program cut off funds for the dual-star guidance system, but the Defense Dept. has been discussing with GPI a possible new source of development money.

Pentagon observers say STINGS looks "particularly promising" as the guidance mechanism for future missiles of one or more of the services.

DOD on Aug. 9 confirmed the cancellation of *MMRBM* (M/R, Aug. 5, p. 15).

X-20 Test Control Changes

Control of the *Dyna-Soar* orbit flight test program has been shifted from Aeronautical Systems Div. at Wright-Patterson AFB, Ohio, to the Air Force's Space Systems Div. (see M/R, July 29, p. 11).

Mission control, which will be similar to the *Gemini* mission control in Houston, will be handled by the Satellite Test Center in Sunnyvale, Calif., which is operated by the 6594th Aerospace Test Wing.

New AMR Center Described

The new multi-functional Range Control Center, due for completion in June or July, 1964, at Cape Canaveral will permit simultaneous launch and control of two vehicles plus global range support for an orbiting spacecraft.

First details of the massive three-story complex, revealed last week at the Cape by Sperry Piedmont Co. officials, stressed that the center will house three autonomous operational areas wherein up to four real-time trajectory plots can be presented simultaneously.

An addition to the existing control center, the expanded facility will serve as communications central for global operations controlled by AMR. Complexity of the center is indicated by the multiplicity of subsystems to be employed: 137 consoles, 800 range instrumentation station displays, 4 real time missile trajectory plots with programable backgrounds, 3 impact prediction plotters, 3 individual countdown and timing systems including 34 TV monitors. Sixty-four operators will man the center.

In operation, the control center will direct and control countdown to T—90 minutes. At that point control will be turned over to the appropriate blockhouses. The center will regain control immediately following launch of each vehicle.

Telstar Transmitting Again

The *Telstar II* communications satellite resumed transmitting at 9:07 a.m. EDT August 12.

Bell Telephone Laboratories scientists, who worked continuously after the satellite ceased transmitting July 16 to return it to operation, offered no explanation for *Telstar's* erratic behavior.

Mars, Pluto Exploration Seen

Dr. Homer E. Newell, Director of NASA's Office of Space Sciences declares that Mars and Pluto are the next planets which will be explored by satellites.

In the introductory lecture at a conference on artificial satellites at Virginia Polytechnic Institute, Blacksburg, Virginia, Dr. Newell defined the significance of the present in space by explaining proposed space endeavors of the future.

Artificial satellites observing not only the Moon, but other planets as well, will yield details unobtainable from earth-based observations, Dr. Newell said.

Other planets to come under detailed observations will be Mars and Jupiter. The possibility of extraterrestrial life on Mars will be fully explored through a comparison of the Martian atmosphere with those of Venus and Earth. Of the major planets, Jupiter will be scrutinized first, he surmised, because of its unfamiliar atmospheric composition and strange temperature fluxes.

Syncom Sets Record

Syncom II relayed voice and teletype messages over a record 7,700-mile distance in recent tests.

The transmissions were relayed between California and Nigeria as the satellite drifted in synchronous orbit at an altitude of 22,300 miles.

Shots of the Week

Two Navy *Polaris* missiles were successfully launched. The first, an *A2* model, was launched from the atomic submarine, Alexander Hamilton, Aug. 9 near the Florida coast. Second shot was of a version designated *AX3* Aug. 13 from a Cape Canaveral launch pad.

Other shots of the week:

- The Army successfully fired a *Nike-Zeus* from White Sands Missile Range, N.M., Aug. 8.
- A *Minuteman* ICBM was launched by the Air Force from Vandenberg AFB, Calif., Aug. 8.

Firms Receive Saturn Pacts

Two firms, Bendix Eclipse—Pioneer Div., Teterboro, N.J., and RCA Data Systems Division, Van Nuys, Calif., have been selected to provide components and equipment for *Saturn IB* and *Saturn V* guidance and checkout systems.

Total cost is expected to be about $15 million.

Bendix has been selected to manufacture and deliver four prototype ST-124M stabilized platform systems and associated electronics—two each for the *Saturn I-B* and *Saturn V* programs. The units are to be delivered over the next 18 months at an estimated cost of $9 million.

RCA has been selected to build six RCA-110A ground computer systems, equipment used for the checkout and launch of *Saturn* vehicles.

NEW from DEI

PUSH-BUTTON PCM SYNCHRONIZER

- Exceptional Stability and Calibration Accuracy
- Correlating Bit Detection
- All Digital Loop Filter
- Wide Dynamic Input Range

NOW—for the first time, push-button bit rate selection is possible!

From Defense Electronics, Inc. comes the latest in a line of PCM Digital Products.

The solid state BRS-1 Bit Synchronizer/Conditioner has been designed for PCM telemetry applications and features accurate setting (within 0.1 per cent) for a known bit rate prior to actual signal reception.

This exceptionally stable and highly accurate synchronizer accepts a serial PCM signal at rates up to 1 mc, automatically conditions the incoming data and generates a stable clock signal.

Automatic circuitry adjusts to input signals over a 40 db dynamic range. The unit incorporates a unique digital loop filter that maintains bandwidth proportional to bit rate at all frequencies. Output of the synchronizer is a reshaped, noise-free, serial PCM signal and a set of clock signals phase coherent with the output data.

The BRS-1—which can be remotely-controlled—performs the functions of data regeneration, format conversion and serves as the "front-end" for any digital telemetry system.

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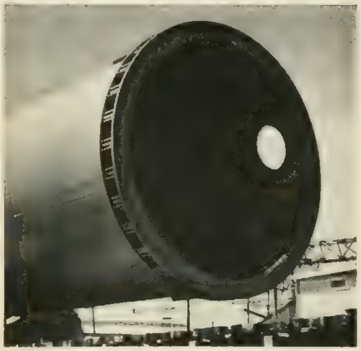
Circle No. 6 on Subscriber Service Card

For the frozen frontiers: a family of steels to which zero means nothing

Strange things happen in the world of ultracold. Some metals get stronger but sometimes so brittle they shatter like glass. Others become superconductors. The load-carrying capacity of some fluctuates wildly. Material selection, in this strange Pandora's Box world, must depend on carefully accumulated perform-



This 56-ft.-long absorber unit is fabricated of A212 steel plate, popular for services requiring notch toughness down to —50F.

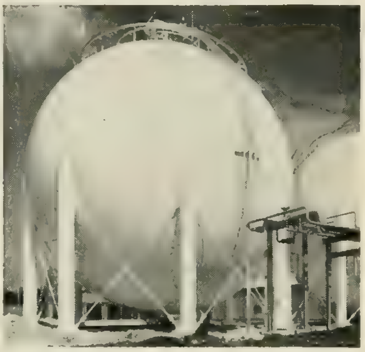
ASTM A201 and A212: for many years the only low-temperature steels available

These two carbon steel grades are widely used for a variety of applications requiring notch toughness down to —50F, such as refrigerated vessels for the storage of liquid propane or ammonia.

ASME allowable design stresses (1/4 tensile) are 15,000 psi for A201 Grade B and 17,500 psi for A212 Grade B steels.

Both grades are available in flange or firebox qualities. When specified to meet the impact requirements of ASTM A300 to —50F, the plates may be furnished in the normalized or normalized and stress-relieved condition to meet the minimum requirements for the specific application.

This mark tells you a product is made of modern, dependable Steel.



USS "T-1" Steel's excellent notch toughness, high strength, and weldability permit high working stresses in low temperature service.

USS "T-1" Steel: can cut pressure vessel weight up to 50%

USS "T-1" Steel combines great strength (100,000 psi min. yield strength), weldability, and low-temperature toughness (15 ft.-lb. min. Charpy keyhole at —50F). It is particularly suited for highly stressed pressure vessels operating at temperatures down to —50F, tank trucks for hauling LP gases, and welded lightweight structures.

Present allowable ASME stress for "T-1" Steel is 28,750 psi for plates up to 2" thick. In non-Code vessels, "T-1" Steel has been used at allowable stress levels as high as 50,000 psi.

In a series of dramatic burst tests, USS "T-1" Steel vessels withstood internal hydraulic pressures up to 2850 psi at about —45F before bursting, equivalent to a circumferential stress of 136,000 psi. Another series of "T-1" vessels, refrigerated to about —45F and pressurized to 1875 psi, were tested to destruction by impact from a 13-ton ingot dropped successively from 52, 73, and 101 feet. An impact energy of nearly 2,700,000 ft.-lbs. was required to rupture the vessel.

This 2¼% nickel steel static altitude test chamber operates at temperatures ranging from —65F to 500F.

USS 2¼% Nickel Steel: down to –75F

2¼% nickel steel has been used widely for tanks, vessels, and piping handling liquid propane and other liquefied gases at temperatures down to —75F. It has been used particularly by the chemical industry for process and containment vessels. Specialized uses include equipment such as static altitude test chambers operating at temperatures as low as —65F to simulate 75,000 ft. heights.

2¼% nickel steel is governed by ASTM A203, Grades A and B. Grade B is most widely used because of its allowable design stress of 17,500 psi compared to 16,250 psi for Grade A.

These steels are also covered by SA-203 of the ASME Boiler and Pressure Vessel Code.

ance data. We have a wealth of such data at United States Steel, plus comparative design studies, that will make your material problems easier. Ask for a USS cryogenics specialist by calling our nearest sales office, or writing United States Steel, Room 6835, 525 William Penn Place, Pittsburgh, Pennsylvania 15230.

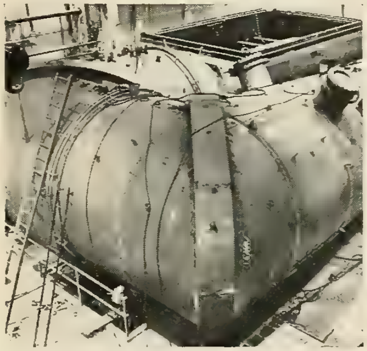
Non-stress-relieved 9% nickel steel vessel was refrigerated to —320F, pressurized to failure—at four times ASME allowable stress. Note ductile manner of failure.

USS 9% Nickel Steel: excellent strength and notch toughness down to –320F

Developed, tested, and proven for cryogenic service, 9% nickel steel offers a rare combination of high yield strength, toughness, and weldability. It is particularly suited for large-tonnage oxygen producing equipment, and for the transportation and storage of liquid methane, oxygen, nitrogen, and argon. Because it doesn't require stress relief after fabrication in most shell thicknesses, it is a natural for large field erected tanks and vessels.

The ASME allowable working stress of 23,750 psi (Code Case 1308) is more than double that of 10,000 psi permitted the aluminum alloy 5083-0. Plate thicknesses can be reduced to less than half those of aluminum with sizeable reductions in cost per square foot.

Where strength is vital, 9% nickel steel is a natural alternate for aluminum. Its ease of fabrication results in substantial savings; data accumulated to date suggest savings of at least 10% of final erected cost compared to aluminum vessels.

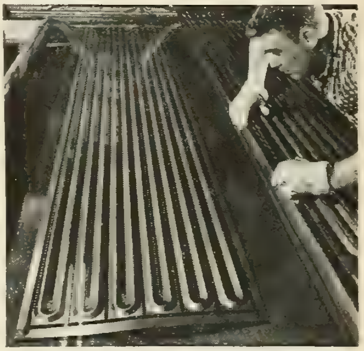


3½% nickel steel wind tunnel simulates, among other things, the frigid temperatures of altitudes up to 16 miles and over.

USS 3½% Nickel Steel: used for land-based facilities and ocean-going tankers

Low carbon 3½% nickel steel has been used for land-based facilities for the containment of liquid propane, carbon dioxide, acetylene, ethane, ethylene and other liquefied gases at temperatures down to —175F. Its excellent low-temperature toughness makes it suitable for use in shipboard tanks to transport liquid ethylene. Its formability, also excellent, has resulted in its use for tanks, vessels, piping, valves, fittings, heads, and many other components.

3½% nickel steel is covered by ASTM A203 Grades D and E. Allowable design stresses are 16,250 psi and 17,500 psi, respectively. These steels are covered under SA-203, ASME Boiler and Pressure Vessel Code.



Type 304 stainless coil heat exchanger retains strength, stability, and shock resistance in cryopump operating at —443F.

USS Type 304 Stainless Steel: the #1 cryogenic metal down to absolute zero

The austenitic chromium-nickel stainless steels, 304 and 304L, are by far the most popular metals for cryogenic service down as low as —459F. They are used widely in liquid oxygen production and storage, and the storage of liquid hydrogen and liquid helium. Wherever high purity is essential, such as handling liquid missile fuels, stainless is a must because its surface remains chemically clean and won't scale.

Type 304 stainless steel is easy to weld and fabricate, doesn't require stress relief after fabrication, and possesses high strength with excellent stability and shock resistance at very low temperatures. Its allowable design stress is 18,750 psi.

USS and "T-1" are registered trademarks.

United States Steel

In view of nuclear treaty . . .

U.S. Presses Vela Hotel Program

Launch due in September-October; McNamara testifies that ban won't jeopardize A-ICBM progress, claims growing missile lead

by David C. Breasted

DEFENSE DEPARTMENT and military service heads are concentrating on success for the *Vela Hotel* detection satellite system and solutions to the knottier anti-missile development problems created by the new ban on atmospheric tests.

Defense Secretary Robert S. McNamara revealed plans for a September or October launch of the blast detection satellite in Senate testimony last week. He also assured the Senate that the atmospheric ban, while complicating anti-ballistic missile development, will not seriously hamper the effort.

The Defense chief led a lock-step parade of witnesses, including Joint Chiefs of Staff Chairman Gen. Maxwell D. Taylor and Atomic Energy Commission Chairman Glenn T. Seaborg, in testimony strongly supporting the test ban up for Senate ratification.

"It has my unequivocal support," Mr. McNamara said of the test treaty before the Senate Foreign Relations Committee. The consensus of all three leaders: advantages of the treaty far outweigh the disadvantages. Senate ratification appeared a foregone conclusion.

But Sens. Barry Goldwater, (R.-Ariz.), Frank K. Lausche, (D.-Ohio), Strom Thurmond, (D.-S.C.), and John Stennis, (D.-Miss.) were among those who bored in upon McNamara about potential dangers to the anti-missile program because the United States can no longer test weapons in air blasts.

• **High confidence**—McNamara stressed that of the factors in an anti-ICBM system, resistance to blackout effects and warhead technology are those at issue in the current debate. He gave this point-by-point reassurance:

—Warheads: "The A-ICBM designs which we now have or can develop through underground testing will provide a high probability of killing Soviet warheads even if they incorporate advanced technology far beyond what now exists."

—Communications and A-ICBM radar blackout: "Soviet and United States experience appears to be comparable although obtained in different ways. . . . By theoretical analysis of presently available data, we believe we can adequately predict effects over the range of yields and altitudes in which we are most interested. We will be able to design around the remaining uncertainties."

—Penetration capability: "Without the confirmation which dynamic tests of re-entry vehicles would provide, we will have to rely on extensive interpolations, and therefore there will be greater uncertainties than would otherwise exist."

—U.S.-Soviet A-ICBM status: "Comparable in magnitude and success. . . . Any deployed system which the Soviets are likely to have in the near future will probably not be as effective, almost certainly not more effective, than the *Nike-Zeus*"—which, McNamara pointed out, was not effective enough to deploy.

His statements were not likely to still Senate critics. But any Pentagon authorities who were uncomfortable about the anti-missile aspects of the treaty were lying low last week.

In the overall nuclear balance, McNamara declared flatly that "the net of the relevant factors is that the U.S. nuclear force is manifestly superior to the Soviet Union's," and that the U.S. "ballistic missile numerical superiority will increase both absolutely and relatively" between now and 1966.

• **Strength in numbers**—The Secretary, while admitting that the Soviets have an edge in yield-to-weight ratios up to the highly touted 100-megaton weapon, firmly backed the position that the U.S. can do a far more effective retaliation job with large numbers of smaller weapons, in which he said this country has a technological advantage.

He said that the Soviets "probably have no missile" for 100-megaton delivery. He also said that a 35-megaton weapon for the *Titan II* could be developed through underground testing.

The Russians, McNamara said, "do not have anything like the number of missiles necessary to knock out our *Minuteman* force," and have no immediate plans for such capacity. ■

THE *VELA HOTEL* launch will fire two 485-lb. detection satellites into circular orbits at 50,000-mile altitude.

The tricky operation will involve lifting the satellies into low-altitude, 100-mi. circular orbit aboard an *Atlas-Agena B.* But the satellite's own Hercules solid motors will put them into highly elliptical orbits with 50,000-mi. apogees. The first satellite will be kicked into its final orbit at apogee, while the other will go into orbit after once around its elliptical orbit. The final orbits are planned to be 140 degrees apart.

If the situation is not right, the second satellite can go around its elliptical orbit more than once.

Mission of the first launch in September or October, which Secretary McNamara announced in Senate testimony, will be to measure background space radiation to distinguish it from nuclear explosion radiation.

The satellites, 5 ft. in diameter, have 20 triangular sides, with X-ray detectors at 10 points around their structures. They will spin at two revolutions per second. In addition to sensors for X-rays, prime evidence of nuclear explosions in space, the packages will carry neutron and gamma-ray detectors.

Eighteen of each satellite's sides are covered with solar cells, about 800 to a side, for a total of 13,236 cells.

Developers at Los Alamos Scientific Laboratory estimate there is a possibility of detecting a 10-kiloton explosion at twice the distance from Earth to the Sun, although some industry scientists are skeptical.

Congress Plans Investigation Of Government-Funded Research

by Heather M. David

TOP LEADERS of the House of Representatives have promised a major Congressional probe of the entire scope of government-supported research, the bulk of which is supported by the Department of Defense and NASA.

The investigation may be performed by a select committee of Congress, or the roles of the committees responsible for authorizing funds may be enlarged so that they can conduct it.

In any case, the study will have strong support. All Congressmen testifying before the House Rules Committee concurred that the approximately $14.9 billion to be spent this year for Federal research is not getting proper supervision.

Of this figure, the Department of Defense funds 55%, NASA 26%, the Atomic Energy Commission 9%, and all other Federal agencies the remaining 10%.

The problem of properly monitoring the vast research effort came to a head this session when Rep. Carl Elliott (D-Ala.) introduced a resolution to create a select committee of five members of Congress (which he later amended to seven) to investigate:

—The overall total of annual expenditures on research programs.

—What departments and agencies of the government are conducting research, at what costs and with what results.

—The amounts being expended by the various agencies in grants for research to colleges and private industry, and in every form of student scholarship.

—What facilities, if any, exist for coordinating the various and sundry research programs, including grants to colleges and universities and scholarships.

Elliott pointed out that five agencies are involved in space research, seven are in oceanography and 14 are in meteorology. While all of this may not be wasteful duplication, he said, some is bound to exist. Other Congressmen recalled a Senate committee report in 1961 which estimated that of $2 billion being spent for electronics research, $200 million represented wasteful duplication.

• **Government labs hit**—One of the areas needing review, said Rep. Joseph E. Karth (D.-Minn.), is the performance of government in-house research laboratories. Karth said that too often in-house research becomes a leisurely project, and its results—unlike those produced by research in private industry—do not enter the national economic stream.

Karth, chairman of the House Space Sciences Subcommittee, also said that because of the lower pay scales offered by government agencies "with a few exceptions, the 1-3% of the scientists who really make the breakthroughs can't be hired by the government." Thus, he concluded, some in-house government research goes to waste.

Karth and other influential Congressmen, including Rep. Olin Teague (D-Tex.), chairman of the Manned Spaceflight Subcommittee, said they would support the creation of a select committee if the existing committees could not carry out the responsibility.

• **Step-up promised**—However, chairman of the three committees responsible for overseeing 90% of government spending said their committees would be increasing their efforts in the near future.

Chairman George P. Miller (D-Calif.) of the House Science and Astronautics Committee said his group has long been hampered by inadequate quarters and insufficient money to hire a staff qualified to permit it to play the role it would like in probing government research. He also pointed out that in this session one-third of his committee was new to the space work, and much time has been needed to bring them "into the picture." He said, however, that much of this groundwork is done, and his staff problems will be alleviated when the committee moves into the new House Office Building sometime after the first of the year. More staff will then be added, and the committee will enlarge its role.

House Armed Services Committee Chairman Carl Vinson (D-Ga.) described the increased scope of his committee's watch over DOD research, which will be subject of a new schedule of hearings beginning Aug. 19. He pointed out that up to June, the committee had jurisdiction only over research and development of missiles, ships and aircraft (amounting to $3.5 billion), but that new legislation this summer gives it control over another $4 billion, or all the remainder of military R&D. Rep. Melvin Price (D-Ill.) will chair the new subcommittee overseeing this new portion.

The Joint Committee on Atomic Energy also has been furnished new powers which multiply by five the amount of funding it has authorization powers over. Rep. Chet Holifield (D-Calif.) told the Rules Committee that JAEC will enlarge its staff in view of this.

Holifield said he did not believe that any five men in Congress could handle all the government research programs, and called for enlargement of existing committee staffs and budgets to do the job. He said he was in sympathy with the resolution's objectives, however, and agreed that the job was not being done properly.

Rep. William L. Dawson (D-Ill.), chairman of the Government Operations Committee, said his committee this session will examine "systematically . . . the Department of Defense-NASA relationships in performance of Government space missions." Other reports to be issued in the latter part of this session and early in the next will cover: new techniques and procedures for procurement of large defense systems, the role of nonprofit contract agencies, regulations to avoid personnel and organizational conflicts of interest in the research and development field, and military communications satellite programs (as a case study of the problems in managing large systems which depend on advanced technologies and involve several Government agencies). ■

X-20A Guidance System Completes Flight-Testing Series

All objectives said successfully met in 7-month Honeywell in-flight test; 6-month sled test to follow

by Charles D. LaFond

EGLIN AFB, FLA.—The seven-month flight-testing of the *X-20A* guidance system has been completed. The highly advanced 255-lb. inertial system is reported to have shown both reliability and navigational ability under the dynamic conditions of flight in an NF-101 jet test bed.

Testing began in December, 1962, following development by Minneapolis-Honeywell's Florida Aeronautical Division, *X-20A* associate prime contractor. There were 23 test flights down the Eglin range to the tip of the Florida peninsula and back. Twenty flights collected navigational information; the last three were used to demonstrate a new technique for reducing inertial altitude error.

T. W. Christensen, Honeywell program manager, said all objectives of the flight-test program were successfully accomplished: system navigational performance was verified and found well within expected limits, validity of an air drag measurement technique for reduction of altitude error was proven, and system reliability was demonstrated under the demanding conditions imposed by extended field operation.

Test engineers, all from Honeywell's St. Petersburg facility, will move soon from the Eglin range to Holloman AFB, N.M. A six-month sled-test program will be carried out there beginning late this fall. The guidance systems will be driven at speeds up to 1,650 ft./sec. over a 30,000-ft. track. Maximum acceleration planned is 8-g, the Air Force says.

One year will elapse between the end of the currently planned guidance test program and the start of air-drop tests. During this interim, the guidance subsystems will be improved and modified physically to satisfy any *X-20A* vehicle modifications.

All of the drop flights will be manned, according to the Air Force. Some will be powered—using the *Dyna-Soar* escape rockets for thrust.

The first of two unmanned orbital flights and recovery are planned by the Air Force for the spring of 1966, beginning the final phase of the *X-20A* systems development.

Guidance system R&D total funding

AF Sees Manned Dyna-Soar Flight by Mid-1966

CAPE CANAVERAL—The Air Force revealed last week that its timetable for *Dyna-Soar* development calls for a manned flight before the end of the summer of 1966.

Brig. Gen. Joseph S. Bleymaier, system program director for *Titan III*, said the first manned *Dyna-Soar* flight will take place before the 17-vehicle *Titan III* development program comes to an end.

Bleymaier gave a partial outline of the *Dyna-Soar* schedule here Aug. 12, after participating in formal ground-breaking ceremonies for the *Titan III* launch facilities.

He said that start of construction marked another "on schedule" milestone for Phase II of the $808-million *Titan III* program, which got under way Dec. 1, 1962, with an Air Force order to proceed with development of the multi-stage space booster.

The general reported that all contractors had met their July 1 target date for completion of all engineering for airborne components such as boosters, telemetry and guidance. He added that contractors responsible for design and procurement of aerospace ground equipment have reported their programs also are on schedule.

- **The plan**—The 45-month development program for *Titan III* (USAF 624A Standardized Space Launching System) calls for construction of facilities here, development of the vehicle in two configurations, and 17 launches.

Present plans are to launch five *Titan IIIA* boosters, each consisting of a modified *Titan II* with a third stage and a control module mounted on top.

The *Titan IIIC* will use the *Titan IIIA* as a core and increase lift with its two strap-on, 120-in. solid rockets, each developing more than one million pounds of thrust. The R&D program calls for 12 launches before Sept. 1, 1966.

Bleymaier said the first *Titan IIIA* is due to be launched in August, 1964, from Complex 20, a converted *Titan I* pad, where all static firings of *Titan III* cores will take place. The first *Titan IIIC* will be launched in April, 1965.

The first three *Titan IIIC* launchings will be made from Complex 40 and the third will send an unmanned *Dyna-Soar* on a single orbit of the Earth. By that time, Complex 41 will be completed and the launch to date by the AF's Aeronautical Systems Div. is about $20 million; Honeywell officials say $16 million more will be required to complete the program as presently conceived.

Concurrently with the Eglin flight tests, the guidance system was wedded to the Honeywell-developed electronic flight control system by Honeywell and the Boeing Company, *X-20A* system contractor, in Seattle.

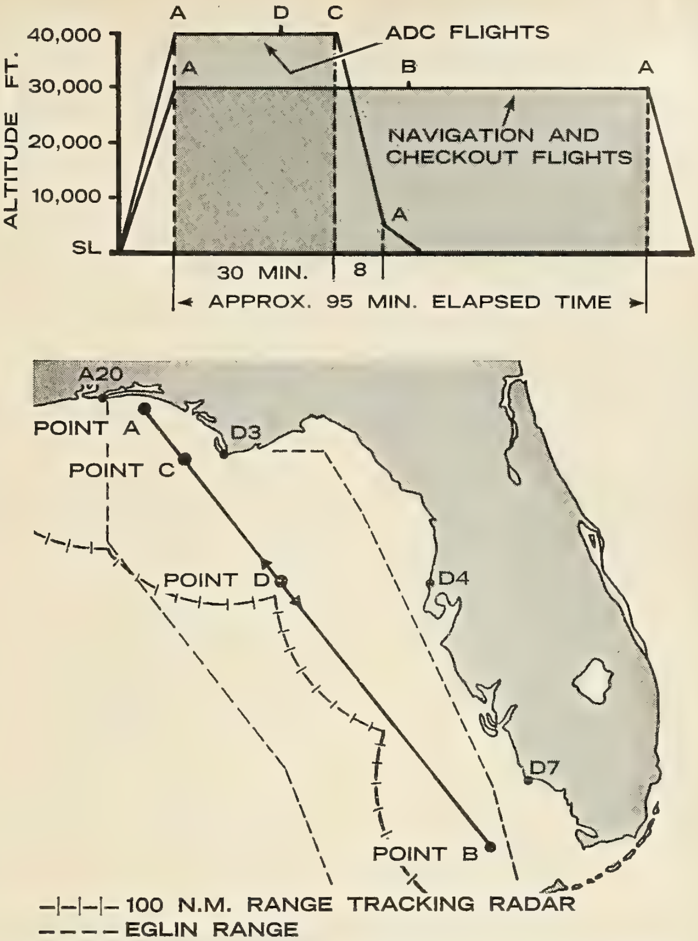
Dyna-Soar systems simulations are now under way at Boeing to provide the data necessary for complete equipment integration.

- **Prototype subsystems**—Honeywell has built five developmental systems. One is used for testing at St. Petersburg, two have been used in the flight tests and will be sled-tested, a fourth is for radio-frequency interference and environmental testing and the fifth is at Boeing for use in systems integration testing.

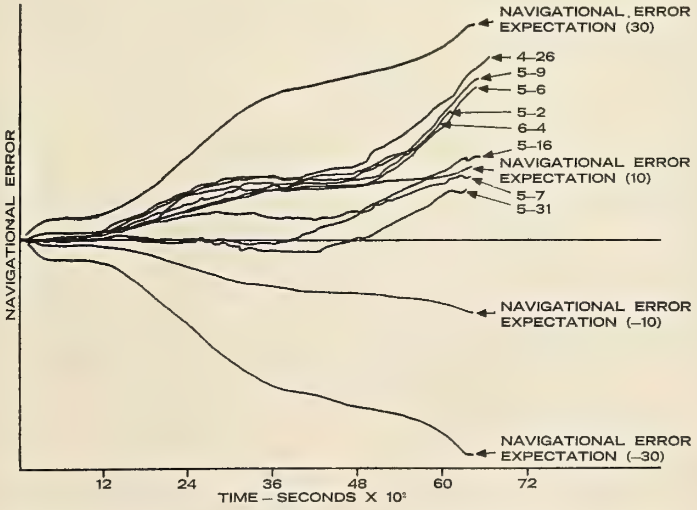
X-20A's Primary Guidance System (PGS) is comprised of four major subsystems. The inertial measuring unit weighs about 40 lbs., and consists of an advanced three-axis, four-gimbal inertial platform with partially integral electronics. Three single-degree-of-freedom gyros are used for reference.

A modified VERDAN digital computer (97 lbs.), developed by Autonetics division of North American Aviation under subcontract to Honeywell, enables real-time solution of motion equations, providing steering signals to the control system and pilot readout data.

(Continued on page 18)



X-20A GUIDANCE System Flight test altitude and true course profiles.



FLIGHT TEST navigation performance curves obtained in X-20A flight tests.

by Chris Butler

rate will be increased.

Bleymaier said the first manned *Dyna-Soar* will be flown before the last R&D *Titan IIIC* is launched from Cape Canaveral.

He said present procurement plans call for delivery of 10 *Dyna-Soar* vehicles, two slated for unmanned flight and eight to carry Air Force and NASA pilots.

The *Titan III* program will require 49 of the huge solid-propellant boosters built by United Technology Center. Of these, 24 are designated for flight and the remainder for testing.

Officials of the 6555th Aerospace Test Wing at the Air Force Missile Test Center said they expect to see their combined military-civilian force double in the next six months as a result of the step-up in the *Titan III* and *Dyna-Soar* programs.

The interface between platform and computer is provided by the coupler electronics unit. It also supplies timing, malfunction detection, and the electronics for gyro torquing and accelerometer rebalance.

Primary power to the other units is supplied by a transient stabilizer, which isolates the system from degrading transients occurring in the main vehicle power system.

The system design is directed toward a mean-time-between-failure requirement of 60 hours, Honeywell said, and the eventual goal is 400.

Identical checkout equipment is employed in the plant and in the field.

- **Aircraft instrumentation**—The aircraft employed by Aero Division, an NF-101B, was flown in all 23 flights by veteran Honeywell test pilot Hank Beaird.

Aircraft modifications included installation of the complete *X-20A* guidance system, a C-band transponder for active tracking (by four range AN/FPS-16 radars) and three standard IRIG telemetry carriers. The latter FM/FM telemetry was provided in three packages, each transmitting outputs from 15 subcarriers.

A telemetry coupler converted digital and analog data from the test system to telemetry format.

Cockpit instrumentation provided displays of specific guidance parameters (heading, pitch, roll, malfunction, and operating voltage). PGS temperature and cooling air pressure also were monitored. A Honeywell engineer observer was provided for each flight test.

- **Flight tests**—Two flight plans were employed. In one, the aircraft flew a course from Eglin to Cudjoe Key in the Florida Keys, a distance of roughly 450 mi., and returned over the same route. Tests began when the jet reached scheduled altitude of 30,000 ft. and the complete test period averaged about 105 min. Average test speed was 477 knots.

During these flights, the test objective was to demonstrate PGS performance and navigational ability when operated under the dynamic conditions of flight in a high-speed aircraft. Platform gimbal dynamics and system angular rate capability also were shown.

Telemetered velocity and position data generated by the PGS were collected for analysis and comparison with ground radar tracking data. To assure meaningful tests results, the PGS was calibrated immediately before and after each flight test. Computer programs compared the two sets of data, and produced plots of comparative guidance system error. (A graphical representation of navigational errors for the last eight navigation test flights conducted is shown in the accompanying curves. Results of the individual flights are identified with the date on which the test was conducted. Honeywell reports that all error parameters for all test flights shown were within the three-sigma error expectation at all times.)

A second flight plan was used to demonstrate the conceptual soundness of the Air Drag Measurement technique for damping the altitude channel of the guidance system during *X-20A* reentry into the Earth's atmosphere.

Starting at 40,000 ft., the aircraft flew at 477 knots (average) downrange, turned and returned. Elapsed time was about 30 min., and a specific fuel weight was retained. The aircraft then reduced thrust sufficiently to maintain a 250-knot airspeed glide, and descended to 5,000 ft. altitude in 8 min., thus terminating the test period.

The air drag measurement technique is based upon a closed-loop computation using angle of attack, total velocity, and total acceleration as prime inputs. From these variables, an aerodynamic altitude is computed and compared with the inertial altitude to generate an error signal. This error signal is fed into the navigational computation through the mass attraction routine and causes the inertial error to converge toward zero.

Honeywell representatives said results of these Air Drag Measurement flights clearly demonstrated the soundness of the concept.

The flight-test program was accomplished by a Honeywell test crew of twenty engineers, technicians, and aircraft mechanics, under the supervision of Test Site Supervisor R. Thompson and Maj. V. L. Rierson, ASD liaison field test officer. ■

NASA RFP Calls for Lunar Base by 1968

HOUSTON—Manned Spacecraft Center's study plans for the manned lunar base environmental control and life support system (ECLSS) call for operating personnel shelters by 1968.

Basic components for a permanent station should be of types available in 1970, but can be dependent upon Earth supply. By 1972-73, dependency upon Earth-supply should be at a minimum, with regenerative ECLSS equipment reprocessing human waste products and utilizing lunar resources to the maximum.

NASA will accept proposals for a six-month study of the system until Aug. 23. The Corps of Engineers has the basic construction contract from NASA headquarters.

- **Basic requirements**—For planning purposes, NASA told aerospace firms to estimate the cost of each pound landed on the Moon at $4,000-$5,500. The cost of each man-hour of ECLSS operation is to be estimated in the wide range between $60,000 and $100,000. At a maximum, the permanent lunar base would support up to 18 men for as long as six months and be supplied each eight weeks by either one *Apollo* spacecraft or a *Saturn V* lunar logistics vehicle.

Center officials warned that the station may be vacant for as long as a year at a time, and that the equipment must be capable of operating after this long a shutdown.

Primary power source should be a nuclear-electric energy system, MSC said, although not necessarily a fission reactor. Fuel cells using hydrogen-oxygen are to be for emergency conditions only.

- **Adding modules**—Contractors were directed to plan for a central ECLSS module after 1970. Environmental control will be a subsystem only during the 1968-70 period, for two-man temporary shelters.

In the 1970-72 period, the basic modules should include a ECLSS module, power module, communications module, maintenance module, and a fuel module to supply lunar roving vehicles.

The complex is to be expanded by 1972-74 with modules containing regenerative life support systems, control modules processing of data by Earth stations, long-range communications modules, and additional maintenance modules and a regenerative fuel module.

- **Size limits**—Transportation to the Moon will be accomplished by the *Saturn V* vehicle, and payloads must be no larger than 245 in. in diameter to fit inside the 250-in.-dia. *Saturn V* "bus." The modular payload can consist of a right cylinder 245 in. in diameter and 100 in. high, topped by a right cone 250 in. high. Maximum payload must not exceed 25,000 lbs. of equipment capable of sustaining 8-g's on launch and 15-g's on descent.

Glad to get letter but . . .

NASA Denies Soviet Moon Proposal

Door left open for future cooperation, but existing contact—not Lovell—would be used for discussions

by Hal Taylor

NASA DECLARES FLATLY that no joint U.S.-USSR manned lunar landing program has been proposed by the Soviets.

The space agency also is killing the idea that Sir Bernard Lovell will serve as an intermediary in U.S.-USSR space cooperation talks.

The official reaction followed an exchange of letters between Lovell, noted British astronomer, and NASA Administrator James E. Webb in which the Briton indicated the Soviets wanted to explore steps which could lead to an international man-on-the-Moon project.

Lovell said the Soviet Union has dropped plans for its own manned lunar landing program and the Soviet space effort was now concentrating on unmanned exploration of the Moon and planets with instruments.

Commenting officially on the letter, NASA said that "it represents the personal impressions of a private individual on a matter of the greatest obscurity, namely the Soviet space program."

"It doesn't seem wise to give the letter any undue importance, although we were glad to get it," the space agency said.

NASA added that, contrary to some reports, the letter does not convey any proposal by the Soviet Academy of Science for the U.S. and USSR to cooperate on a lunar program. "It only raises the possibility of discussions of the scientific reasons for the manned lunar landing program," the space agency said.

"We already have a channel of communication, namely the discussions between Dr. (Hugh) Dryden (NASA Deputy Administrator) and Soviet Academician Blagonravov. It is reasonable to expect that channel would be used for a serious proposal," the agency concluded.

The NASA statement was released following disclosure of the contents of the Lovell letter by Sen. Clinton P. Anderson (D-N.M.) during debate on NASA's Fiscal 1964 authorization bill.

- **More doubters**—Other Kennedy Administration officials joined in taking a pessimistic view of the chances for cooperation in the manned space area.

Dr. Edward G. Welsh, executive secretary of the White House's National Aeronautics and Space Council, told MISSILES AND ROCKETS that "at this point, I don't attach any significance to the Lovell letter."

"I also don't think that it is any basis to expect cooperation with the Soviet Union on a manned lunar landing program in the future," he added.

Welsh pointed out that the possibility of cooperation in the manned space area was brought up in the early discussions between Blagonravov and Dryden.

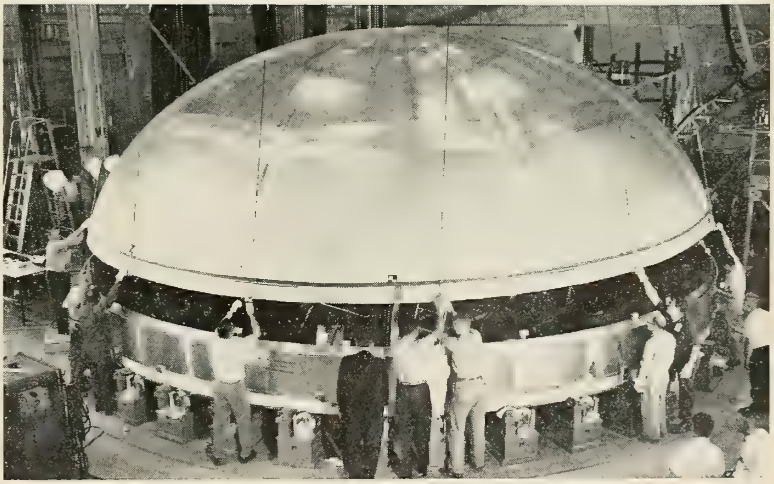
The Russians rejected the idea, but indicated that cooperation might be possible after the lunar landing program, Welsh said.

The strong reaction of U.S. officials apparently stemmed not only from mistrust of Soviet intentions, but also the fear that the Lovell letter could reduce congressional and public support of the NASA program.

The road to future cooperation was left open, however, by the space agency's statement that serious proposals for a joint effort could be discussed by Dryden and Blagonravov.

- **Motives**—Lovell said Soviet scientists gave three reasons during his recent trip to that nation for rejection for the time being of plans for a manned landing on the moon. He said Soviet scientists see no solution at present to the problem of protecting cosmonauts from the lethal effects of outbursts from the Sun. He added that they have devised no economically practical way of launching enough material to the Moon for "a useful manned exercise."

Also, said Lovell, "the Soviet Academy of Science is convinced that scientific problems involved . . . can be solved more cheaply and quickly by their unmanned instrumented program." ■



Beginning First Saturn V Fabrication

UPPER DOME of a fuel tank for the Saturn V booster is lowered into place on a "Y-ring" to which it will be welded at the Marshall Space Flight Center. Two tanks, with connecting skin segments, will form the main fuselage of the Boeing S-IC first stage of the booster, which will be powered by five F-1 liquid oxygen/kerosene engines developing a total of 7.5 million lbs. thrust. The fuel tank work begins Marshall's fabrication of the first static model booster.

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The job: To develop control systems instrumentation. Required: Knowledge of transduction, instrumentation, data acquisition and processing. Degree: BS in EE or Physics. Experience: A year or more.

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The job: To test solid motors . . . all that the word implies, from start to finish. Methods, equipment, procedures. A variety of assignments available, depending on degree and experience.

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The job: Stress analysis on big, big rockets. Required: Experience in complex shell and semi-monocoque structures, knowledge of scale model static and dynamic analysis. Degree: BS and 1-5 years experience.

you

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The job: Apply your knowledge and experience in wiring systems, ordnance checkout, performance analysis, trajectory and load study, vehicle and structure design, inadvertent separation systems. Required: BS in ME, AE, or Physics.

LIQUID AND ENVIRONMENTAL TEST ENGINEERS

The job: To build, test, and evaluate ablation chambers, tankage, TVC, and liquid ignition systems and perform environmental tests. Required: BS and experience appropriate to assignment.

me

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The job: To study space booster's response to high intensity noise, turbulence, transportation dynamics, and other steady and dynamic loads. Work is theoretical and experimental. Required: Advanced degree and 1-5 years experience.

SENIOR DESIGN ENGINEERS—AGE

The job: AGE systems design, analysis, procurement, checkout. Required: BSEE with about four years experience in AGE test and ground instrumentation and support systems.

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Took Tommy to the dentist, back soon. Meanwhile, look what I found in this morning's paper !!!!

gust 5. Call Jim Ferguson, QU 7-3301.

WILLY MAYS, I bet my shirt you'd hit .330. Don't lv me out in the cold. A fan.

REWARD OFFERED for bright ideas pertaining to solid or liquid rockets, hybrid engines, solid propellants, AGE, etc., etc. See UTC advt. Classification 51.

UTC WIVES GOLF CLUB now forming. Weekly foursomes of beginners, intermediates, and experts. Club rental and instruction arranged. Details, call Betty McCormick, QU 8-7659, days or eves.

SPECIAL NOTICE FOR SHOOTERS PISTOL MEET—SUNDAY. This Sunday afternoon at 2:00 there will be a special pistol meet between a team from United Technology Center's Pistol & Rifle Club and the Sixth Army Pistol Team from the Presidio of San Francisco. This event will be held at the Sunnyvale Police Academy. There will be a special display of trick shooting by members of each team before the match. Also: Old West fast-draw exhibition and re-enactment of a Dodge Cit shootout. Free admissi everybody welcome. C dren under 14 must be companied and super by parents.

YOUNG MEN ATTENTION UTC Engineer with rs' degree will trade tutoring (HS or Col help in excavating fo yard swimming pool Harry Osborne, QU 8- eves.

GOURMETS' HT YOUNG MARRIE OUP now being for tour San ous restife. Trips twice a ation armember- 7-3447.

secure portation in the form pools, etc., if you live in the Santa Clara Valley. We also have organized BOWLING LEAGUES for men and women, an AIRPLANE CLUB with reduced fl g and instruction rat a GOLF LEAGUE a BRIDGE CLUB. O ecreational and leis tives also availab OUP TRAVEL now ar ranged for fam its to Disneyland, ART LEAGUE begin next month.

DISCOUNT TIC available for Giant all games, SF theater ncerts, and special ions. UTC needs d engineers and ns. See current ments in UTC ad assification 51. Help ed—Men.

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NTAGE CAR CLUB of San Francisco Peninsula will not meet this month. Next regular meeting will be held following Concours d'Elegance in Monterey on the 25th. Details from Secretary, QU 8-6681.

FOR SALE: Hi fi console. Stereo with 2-30 watt amps. FM tuner with AFC, automatic record player. Each speaker system (2) contains 12" wooer, 8" midrange, and horn tweeter. All in beautiful walnut cab. Make offer. Charles Webb, QU 8-1135, eves & weekends.

SNOWSUITS sizes 2 and 4. Used one week in mountains. Make offer. QU 8-9454.

SEASCOUT being formed in irst meeting in bldg. TC Friday 7:30 p.m. ents and boys 11 and over invited to attend. Former Seascouts welcome and needed. Refreshments served. More info., call QU 7-8856.

BABYSITTING POOL BEING FORMED by UTC wives in Sunnyvale and elsewhere in Santa Clara Valley. Object: Low-cost, no-cost baby tending. New members welcome. Call Pat Robinson, QU 7-3323.

FOR RENT—3 bdrm. furnished cottage shower, TV, on the Bay Robinson Beach, good fishing close by, swimming in season. Schock Realty QU 8-1414.

26' double ender metal life

WEEKLY CAR POOLS FORMING Peninsula engineers and scientists forming car pools to Berkeley campus, Univ. of Calif. to enjoy stimulating solid-state lectures. Thursday eves. Some golf and tennis foursomes also

CQ, CQ, CALLING CQ Ham rig just arrived from the East. Now setting up shack. Like to meet local hams. Be on the air by Sunday night, testing gear and antenna on 20 meter band. Talk shop, Minnesota, California, what have you. Give us a

34' double ender metal life

27' OWENS cruiser, ship shore

Technical Countdown

ASTRONAUTICS

Spin Probe To Sample Atmosphere

A probe designed to sample the Earth's upper atmosphere for nuclear debris between 125,000 and 190,000 ft. will be launched from the Tonopah Test Range, N.M., under the direction of Sandia Corp. for the AEC. The vehicle is a parachute-supported canister launched by an *Honest John-Nike* rocket system. Rotor blades containing the sampling filters will be unfolded at start of descent. A constant-spin propulsion mechanism supplied by Space General Corp. will maintain uniform rotation. The unit is powered by hydrogen peroxide, pressurized by nitrogen and weighs 55 lbs. An 8-oz. control package from Space General will count the number of rotations using the sun as a reference.

Now NASA Digs 'Program Definition'

Westinghouse Defense Center has been awarded a contract employing a program-definition phase remarkably resembling that which has become standard of late from DOD. It calls for the study of a new non-military navigation satellite system. The goal is reported to be designed for a practical space system at minimum cost capable of being effectively used by "aircraft and ships in any kind of weather."

ELECTRONICS

'Fallthrough' Yields New Celestial Tracker

A new solid-state scanning system for celestial tracking applications has been proposed to NASA and the AF's Aeronautical Systems Div. Developed at Belock Instrument Corp. in New York, the device is based on "a scientific fallthrough"—the accidental discovery of pulsing action resulting from light beams coinciding on a photoconductive material. The small (4-in. dia. x 8½-in.) low-power (under 10 watts) tracker uses a telescope system to focus energy from a target onto a single-element photodetector. Behind the detector is a solid-state high-resolution (reportedly in excess of 300 lines per inch) electro-luminescent panel which serves as the second light source. Conductors in the panel are energized sequentially, scanning the detector at high speed. When target and panel beams coincide, a pulse is formed which gives a direct digital readout of target location within the detector field-of-view. Signal amplitude indicates target intensity but output is not digital. The panel is a glass substrate upon which a fine wire matrix is deposited. The wires are coated with phosphorus and then a transparent wafer covers the package. S/N ratio of the system, which operates in both visual and IR ranges, is said to be 10:1.

Anti-Missile Laser Beams Envisioned

Striking down enemy missiles during their ascent phase by means of a laser beam emanating from an Earth-orbiting space station is the subject of a recently revealed Dept. of Defense study. It was described as possibly leading to one of many R&D projects capable of being accomplished from a space station such as the Air Force's proposed Manned Orbiting Development Station (MODS). Although the practicality of an energy beam strong enough to destroy an enemy vehicle is admittedly far-fetched today, some observers feel it is no more so than was the long-range bomber envisioned during World War I.

Microsecond Laser Likely

Plugging of the microsecond gap in the laser pulse spectrum is likely soon in commercial equipment. Korac Corp., producer of lasers with nanosecond and millisecond pulse widths, is developing such an ultrashort-pulse laser. Korad also is operating experimental lasers with inputs of several hundreds of watts. Chief problem is boiling of the liquid nitrogen used to cool the semiconductor chip.

Bendix Gets Saturn Guidance Follow-On

Inertial guidance platforms for *Saturn IB* and *V* will be built for NASA's Marshall Space Flight Center by Bendix Eclipse-Pioneer Div. under a contract expected to total $9 million. The platform design, it is reported, will be an improved version of an earlier unit developed by Bendix for *Saturn I.*

R&RR Ready for Installation

Two of the three advanced Range and Range Rate tracking systems developed by Motorola for NASA's Goddard Space Flight Center will be installed soon at Carnarvon, Australia, and Rosman, N.C. The third will be maintained by the firm at its Scottsdale, Ariz., facility as an engineering test system and experimental tracking station until its ultimate delivery to NASA. It will permit active tracking in range to within 15 meters and in range rate to ±4 in./sec., the company claims.

ADVANCED MATERIALS

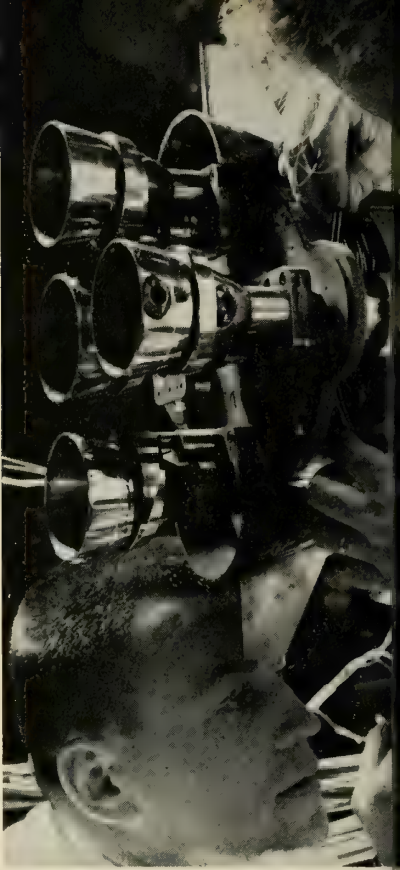
Superconducting Magnet Exceeds 60 Kilogauss

Varian Associates is marketing a superconducting magnet generating a field in excess of 60 kilogauss with better than 1% homogeneity over a field 2 in. long and 0.5 in. across. The field can accommodate samples from room temperature down to liquid helium temperatures through an isolation dewar. In the Varian design, the central portion of the magnetic field is effectively flattened without excessively long and expensive coil windings. A computer was used for the intricate calculations needed in the design.

SPACE MEDICINE

New Space Environment Tests at SAM

Air Force medics at the School of Aerospace Medicine, Brooks AFB, Tex., continue their search for the optimum space cabin environment. In the latest test, which will last 43 days, four Air Force volunteers are living at an altitude of 2,000 feet, with only 10% more oxygen than that at sea level. This is the longest of the Air Force tests, with particular emphasis on blood, heart, lungs, eyes and kidney performance at varying gas mixtures and altitudes.



Cornell Tests Aim at Base-Heating Guidelines

NASA says highly successful CAL techniques have cut booster model test costs by 80%

by Michael Getler

BUFFALO, N.Y.—U.S. missile and space booster designers, bothered since the mid-1950's by certain doubts about the pattern and effect of base-region heating in multiple engine configurations, may soon have an effective set of guidelines to work from.

Engineers at the Cornell Aeronautical Laboratories here, who have been studying this problem for several years, will embark next month on an extensive series of tests to collect base region design data for a wide range of possible missile/space engine configurations.

Kenneth C. Hendershot, chief of CAL's propulsion section, told M/R that the lab hopes to prepare a basic guidebook on base heating criteria. Initially, he reports, the lab will run several hundred scale model tests, probably over 2 to 3 months, varying virtually every design parameter in stages with from three to eight clustered engines.

About the time CAL begins the parametric study for NASA, using basically state-of-the-art engine design criteria, the lab will also start another NASA test program, which will subject both industry and NASA (Marshall SFC) models of advanced *Nova*-type stage designs, including various unconventional plug nozzle shapes, to the short-duration test methods developed by CAL.

Base heating problems were first encountered in 1956 during *Atlas* test shots. The problem was blamed on clustered rocket engine configuration. At higher altitudes, generally above 50,000 ft., rocket exhaust plumes impinge on each other causing some expelled gas flow to move back into the missile base region where it can overheat or overstress inadequately protected wiring, hydraulic gimbal actuators, or other components.

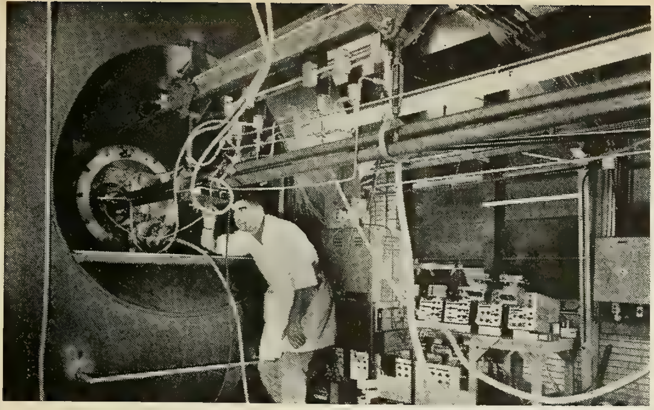
The base heating problem is not new, but specific values relating to its flow, forces, and its protection requirements have remained uncertain.

In most cases, manufacturers combat the problem by using heat shielding combined with gimbal seals or open bases with air scoops to route free stream air to purge the recirculating gases. However, as CAL engineers point out, in may cases the amount of heat shielding required, its proper location, and the loads to which it might be subjected have been largely guesswork.

- **Feasibility studies**—CAL's entry into the base heating area came late in 1960 when a CAL proposal convinced NASA to provide the laboratory with funds to prove the feasibility of using short duration test techniques to solve some of these problems. CAL proposed this method based on several years of experience with developing shock tubes capable of generating controlled flows of high temperature, high velocity air for short periods. Accompanying development of the tubes was development of very sensitive heat transfer and pressure measurement instruments capable of recording data in tests of milliseconds duration.

In addition to supplying data in a field where it is hard to come by, the ability to relate these techniques to scale model testing of booster systems will offer considerable economic pay-off in comparison to use of long duration (10 seconds and up) continuous-burn testing.

Problems associated with the longer duration tests are numerous. Modeling itself is much more difficult. Model engines must be virtual miniatures of actual engines. Extensive cooling systems are required to remove heat from model nozzle throats exposed to relatively long flows of exhaust gases; an elaborate fueling system is required. Test chambers must have extensive vacuum pumping capabilities for maintaining required pressures and for removing exhaust gases.



LEFT: *CAL technicians install instrumentation in a Saturn S-1C stage model in preparation for base-heating tests.* **ABOVE:** *Supply tube setup leading to high altitude simulation vacuum chamber.* **RIGHT:** *Heat transducers on surface of Centaur model pick up surface temperature.*

In contrast, short duration (between 5-20 milliseconds, depending upon altitude simulation) testing provides nearly instantaneous establishment of a hot steady flow lasting just a few milliseconds and permits use of simple models without cooling. There are also advantages with respect to the test chamber. For high altitude simulation, where there is no external airflow requirement, short duration tests can be run in a simple tank type vacuum chamber with only slight vacuum pumping capability. Tank size in general is dictated by the relationship between required test time and the time it takes for shock waves generated in the combustor to pass through the model engine nozzles, bounce off the end of the tank, and return.

For tests run at lower simulated altitudes where an external air flow is required, short duration methods can also be easily applied in wind tunnel facilities, CAL reports.

- **Test set-up**—The CAL approach to generating short duration energies has evolved from a constant-volume technique to a constant-pressure method.

In the latter, two metal tubes, each of roughly 2-in. dia., are used to store gaseous oxygen and hydrogen separately under high pressure. When diaphragms at the forward end of these tubes are mechanically burst, an expansion wave forms in each tube, feeding the gases into a combustion chamber and then out through the nozzles. Since the sound waves formed in the different tubes travel at different rates depending on the gases contained, the tubes are made of unequal length to match time factors. Roughly 1 ft. of tube length equals 1 millisecond of test duration.

In the constant-volume technique, pre-mixed gases were ignited in a single tube using a series of sparkplugs. It was found that the constant-pressure technique is easier to work with in that mixing problems are removed, heat losses are minimized, and test durations can be increased since the waves travel through cool rather than hot gases in the tubes.

In discussing the actual economies of the CAL methods, a NASA project official at Marshall SFC told M/R that these procedures have reduced the cost of base-heating testing by almost an order of magnitude, actually about 80%, from that of long duration runs. In general, he reports, results were as good as with long duration tests and were in agreement with subsequent flight test values.

A new short-duration base-heating facility will be in operation at Marshall within 6 months, NASA reports, "the same thing down the line as the CAL facility." It will be used as a back-up for the Buffalo facility and also to take over some of the routine test functions.

- **Sensors**—The two major sensing devices are heat transfer elements and pressure transducers, both developed in-house.

The heat sensor is actually a resistance thermometer made by depositing a thin (1 micron) strip of platinum on a $\frac{1}{16}$-in.-thick, $\frac{3}{8}$-in.-wide pyrex glass. The device, with a 75- to 125-ohm resistance and less than 1-microsecond response time, is oven-fired for bonding, and electrical contacts are made at the end of the strip. CAL reports it has developed an analog circuit to automatically take temperature vs time output to provide real-time data on heat-rate vs time, avoiding an otherwise laborious conversion sequence.

The pyrex modules also have another platinum strip on the back side of the glass at right angles to the front strip. The glass thickness, CAL reports, is sufficient to allow the front face to sense both the convective and radiant heating, while the back face feels only the radiant heat, making it possible to separate the two components for more meaningful design information.

The pressure transducer uses self-generating piezoelectric elements and is capable of measuring pressures as low as 0.001 psi. The $\frac{3}{8}$-in.-dia, $\frac{1}{8}$-in.-thick device, used to give circulation patterns and load strength, has a built-in acceleration compensation and is said to have a frequency response in excess of demands of short duration testing.

- **Saturn program**—With feasibility of short duration testing proved late in 1961, NASA directed CAL engineers to bring this technique to bear on virtually all stages of the *Saturn* booster program, and, to a lesser extent, on the *Centaur* engine.

The CAL interest initially centered on the high-altitude (above 120,000 ft.) vacuum chamber tests where no external airflow is required. Much of the early lower altitude and higher airflow work in this area went on at NASA's Lewis Research Center and the AF Arnold Engineering Development Center.

However, the CAL study has now expanded to lower points in the trajectory. For example, tests on the *Saturn* S-1C stage model have been completed for the high-altitude portion of the trajectory in the 13-ft. vacuum chamber here. Tests also run here included use of the CAL 8-ft.x8-ft. transonic wind tunnel to simulate the 13,000 ft. to 34,000 ft. portion of the flight.

This month, CAL engineers will take the S-1C model ($\frac{1}{45}$th scale of actual 33-ft.-dia. stage) to Lewis to complete

Perfect Atlas Record in Launching Manned Mercury Orbital Flights...

MA-6

MA-7

MA-8

MA-9

RELIABILITY SUMMARY–Here are some of the specifics which contributed to the Atlas-Mercury 100% success:

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Demonstrated Atlas Reliability Now Applied to Atlas SLV-3

The latest outgrowth of the continuing Atlas program is the United States' first *Standardized* Space Launch Vehicle, Atlas SLV-3. Atlas SLV-3 is already specified, and in production, for several USAF and NASA space programs, involving over 30 launches.

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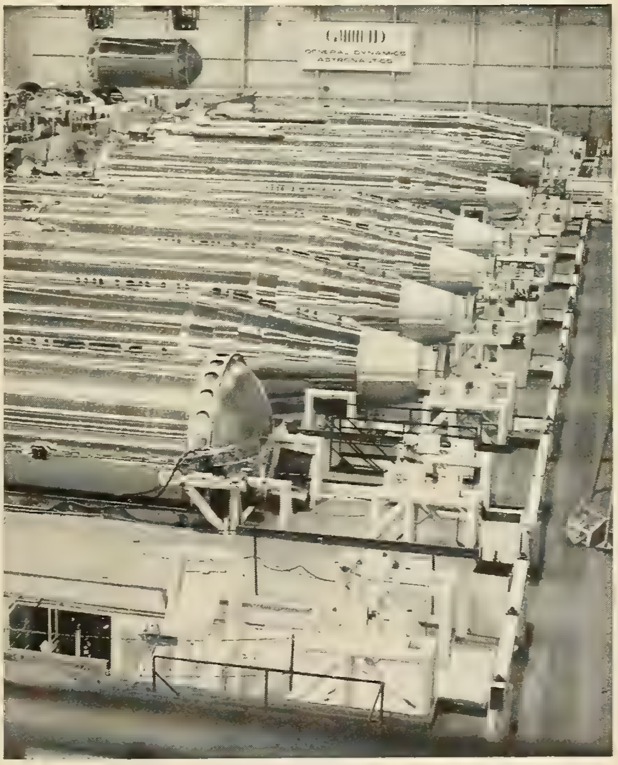

GENERAL DYNAMICS

ASTRONAUTICS DIVISION

SAN DIEGO, CALIFORNIA

ENGINEERS & SCIENTISTS

ALL CHIEFS, NO INDIANS!

With tongue in cheek, this phrase might be applied to the scientists and engineers of Pan Am's Guided Missiles Range Division. Under the direction of the U.S. Air Force Missile Test Center, GMRD has, since 1953, been responsible for conceptual planning, specifications, and operation of the range instrumentation systems developed by industry for the Atlantic Missile Range. The decisions made by Pan Am's technical staff are vital... directly affecting the success of each missile, space vehicle, and scientific probe launch operation at Cape Canaveral.

RANGE PLANNING analyzes projected program requirements up to 15 years ahead, predicts range support capability required and develops the advanced instrumentation system concepts.

SYSTEMS ENGINEERING utilizes these range plans to develop detailed specifications for all range instrumentation, data, and support systems. They then evaluate bids from industry to insure that capable industry sources will furnish such systems. This is only the beginning of their task—they follow and monitor the development of this equipment through installation and checkout.

RANGE OPERATIONS plans and evaluates range support for all launches, coordinates all range support activities, provides data and command/destruct for range safety, and manages the operation of down-range stations.

Individually and as team members, the men in these groups have become authorities in range technology. To add to the capability of the range, the following typical assignments are under way in Range Planning, Systems Engineering, and Range Operations:

CW and Pulse Radar: modify and improve sensitivity of Mistram, Glotrac, AN/FPQ-6, and AN/TPQ-18; develop velocity measuring system with an accuracy of 0.1 fps.

Telemetry: increase the operating range of antennas to cover frequencies up to 2300 mc; design a system which, upon command, will select the most important data from each station.

Optics: devise and install an orientation system for both CZR and cinetheodolites; improve ballistic cameras with respect to random errors, shutter speed, exposure time and time correlation.

Infrared: develop high resolution spectrometer for launch and re-entry coverage; implement a complete infrared measurement system for mid-range coverage.

Underwater Sound: introduce a nuclear battery power supply into the ship-tended acoustic relay (Star) and extend the range of this system.

Data Processing: add automated methods to enable more efficient handling of larger volumes of data with minimum degradation; convert processing of weather information to near realtime.

Meteorology: improve cloud height and growth indication instrumentation; develop a system to measure atmospheric electrical potential and cloud movement.

Instrumentation & Vehicle Control: automate the entire tracking network through a Range Instrumentation Control System; add space diversity to the Cape Canaveral command control system by adding a van-mounted 10 KW fast-reaction command control system.

Correlation: reduce time correlation uncertainty across the range to less than 100 microseconds; standardize the timing signal format on the AMR.

Radiometry: schedule and control all electromagnetic radiation within the missile test area with a Spectrum Surveillance System; automate, where possible, instrumentation for interference control, spectrum signature collection and quality analysis.

Data Handling: design equipment to permit very high density realtime data transmission over RF lines or submarine cable; increase the digital data equipment available at off-cable sites to provide more efficient on-site computer programming.

Range Safety: increase the electronic monitoring of launch hazard areas and of missile and spacecraft performance; install a second Range Acquisition Data Distribution & Control system to permit handling of dual missions; develop instruments to measure blast parameters and fireballs resulting from exploding missiles.

Ship and Aircraft Instrumentation: improve the instrumentation to meet more stringent telemetry, navigation, tracking, communications, and data handling requirements; phase into operation new and/or modified tracking ships and aircraft.

Capable engineers and scientists with applicable experience are invited to write in confidence to Manager, Range Development, Dept. 56H-3

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the test series, using the NASA continuous flow tunnels (with the short duration techniques) to complete the Mach 0.8-2.0 and 2.0-3.5 portions of the trajectory.

About 300 different tests are estimated for the complete S-1C program, which began in March 1962 and is expected to be finished in December 1963. Engineers point out that the test rate is very high, about 10-20 tests in a 16-hr day using the short duration methods. In a typical model, CAL says they can make about 40 measurements at one time, with a model actually instrumented for a maximum of 60-70 points.

With the Boeing S-1C stage, CAL will either verify the initial Boeing design or will note possible modifications based on effects of various air scoop sizes or engine gimbaling and turbine exhaust effects.

Though these efforts (combined with other sub-system considerations) may aid in finalizing S-1C base region design, CAL moved into the S-1C testing program, as it did the S-IV stage and the *Centaur,* basically after prototype development had been done by the manufacturer.

● **S-II effort**—However, in the case of the North American Aviation S-II stage, 8 months ago CAL started a parametric study of all factors affecting base region design—number and arrangement of nozzles, heat shield location, turbine exhaust duct locations—and came up with a set of values, which NAA then cranked into stage design.

CAL is scheduled to start tests this week on a model of the S-H developed after these initial study inputs. About 250 tests will be needed. It is this type of early study before fabrication wherever possible in stage design, followed by short duration test sequences, that will yield the greatest technical and economic pay-off, CAL emphasizes.

CAL reports that all liquid hydrogen-liquid oxygen stages (*Centaur,* S-IV, and S-II) are simulated using oxygen and hydrogen gases in the test set-up. The LOX/RP-1 propellant in the S-I and S-1C is simulated with gaseous oxygen and ethylene, which CAL engineers say provides a good simulation of the stage exhaust products after combustion.

Though engineers here say that test control and injection is easier with gas than with liquids, CAL is now studying ways to extend use of these test methods to cover the storable liquids, which do not have gaseous counterparts for simulation. One approach simply involves trying to use the constant pressure combustor with liquids by refining design. The other, for which there is more optimism, involves using a shock tube filled with a gaseous mixture exactly like the actual liquid fuel gases leaving the nozzle. These gases would be heated by a shock wave and expelled through the nozzles without combustion.

● **Other programs**—With these other liquid test procedures developed, *Titan II ICBM, Titan III* transtage, *Apollo* service module, and *LEM* ascent and descent stages could all probably undergo these short duration tests.

The NASA support of CAL's efforts in this area totals more than $1.5 million thus far and also extends into other programs.

For example, CAL reportedly has demonstrated feasibility of these test methods for solid ullage rockets needed to accelerate the S-II stage in a zero-g environment. NASA's concern is with impingement of solid-fuel exhausts on airframes. These tests are about to start.

The lab will also look at possible impingement problems which exist during S-IC–S-II separation. Already completed is a program in which shock tube heated hydrogen at 4,500° F was passed through a *Nerva* engine nozzle throat to check high temperature effects. ■

How to Succeed in Business Without a Profit

Cornell Aeronautical Laboratories' 57-year-old president Ira G. Ross has dropped the term "not-for-profit" in describing the independent research laboratory he directs. Though the term remains in use at other "non-profit" (the phrase he prefers) institutions, he suggests that it is improper in almost any situation.

"Not-for-profit," he told M/R "implies that there is a profit but that profit is not the motivation. Actually, in our structure, not only is it not the motive, but there is no profit in the conventional sense.

"There is a net fee, usually about 5%, attached to our contracts," Ross points out, "but with one minor exception, this is spent on new capital equipment and company sponsored research, which are considered as business expenses of a commercial company. Except for about $50,000 annually which is added to CAL's working capital, there are no residual monies to be distributed to owners or stockholders." CAL is wholly owned by Cornell University and operates as an independent subsidiary organization.

Ross breaks down the CAL fee distribution to show about 50% going into new speculative equipment, about 25% into company sponsored research, and the rest to cover certain non-allowable operating costs.

Ross describes CAL as independent non-profit, in comparison to the "captive," service-created non-profit corporations such as Mitre, Aerospace, Rand, and SDC. CAL, he says, "is more akin in reason for being, structure, and purpose to institutions such as Battelle, Stanford Research, and Illinois Institute of Technology.

● **Early in the idea stage**—"The place of the independent non-profit is for the most part in the early conception phase of an idea. We're ideal for this," Ross stresses, "we're objective and not pre-disposed to any solution since we don't make anything. With no product line to feed, we can move more freely in any research direction than can industry, and generally with more objectivity than the captive service non-profits, who," Ross says, "tend to take on the aspects of the military.

"What the outside lab does," he says, "is a cross-pollination job," dipping into several technologies—generally outside what may be limited areas in which solutions are being sought—where possible alternatives may lie.

Though Ross feels the military needs both types of labs, he stresses that the independent laboratory can get more outside viewpoints into the military. "The service lab may have this at first, but it fades as its employees lose touch with other industries and other technologies."

Ross describes CAL's research freedom as lying somewhere between the anarchy of a campus and the profit making company aiming its research at a product line. CAL's business is split roughly in half between government and industry sponsorship, but over 90% of it is military oriented. About half the applied research carried out here is involved with the two "centers of competence" in which Ross feels the laboratory is at the front of the technology—hypersonic aerodynamics and microwave propogation with particular emphasis on radar cross section efforts and high power discrimination radar capabilities. These two areas interact in the plasma/microwave area where Ross also sees strong potential building up.

Syncom II System Opens New Doors

THE HYDROGEN-PEROXIDE jet control system which successfully adjusted the *Syncom II* satellite's velocity has a one-year operating lifetime.

The system, which ushered in a new approach to satellite attitude and velocity control, was used to cut the satellite's daily drift rate from 4½ degrees east to the desired 5 degrees west.

Developed by the Aerospace Division of Walter Kidde & Co. Inc., Belleville, N.J., under subcontract to Hughes Aircraft Co., designer and builder of the spacecraft, the 3.35-lb. system carries a 5-lb. charge of 90% hydrogen peroxide, plus .18 lbs. of nitrogen pressurant gas.

Syncom II actually uses two completely independent control systems. The hydrogen-peroxide system provides the gross velocity corrections and has a velocity correction capability of over 300 fps.

A cold-gas nitrogen system developed by Hughes provides the vernier adjustments and has a 47-fps correction capability.

The peroxide reaction control system consists of two spherical tanks used for both hydrogen-peroxide and nitrogen gas storage, a combination filler, relief and vent valve, two thrust motors and valve assemblies, and a pressure transducer.

The system is armed by charging with 90% hydrogen peroxide and nitrogen pressurant gas in sequence. The fuel levels are equalized in both tanks, mounted opposite each other, since they are interconnected through manifolding. A regulated supply of nitrogen is introduced to achieve a system pressure level of 200 psi at 70°F.

- **Actuation and shutdown**—Rotation of the system about its spin axis completes the arming procedure by positioning the propellant at the outboard portions of the tankage, where manifolding connects the two tanks and the valve thrust motor assemblies. Actuation of the desired thrust chamber is accomplished by a command signal from the *Syncom* ground control equipment. The signal opens the solenoid-operated propellant valve, allowing peroxide to pass through the catalyst bed in the thrust motor, where it is decomposed into superheated steam and oxygen and then expanded through converging-diverging nozzles producing thrust.

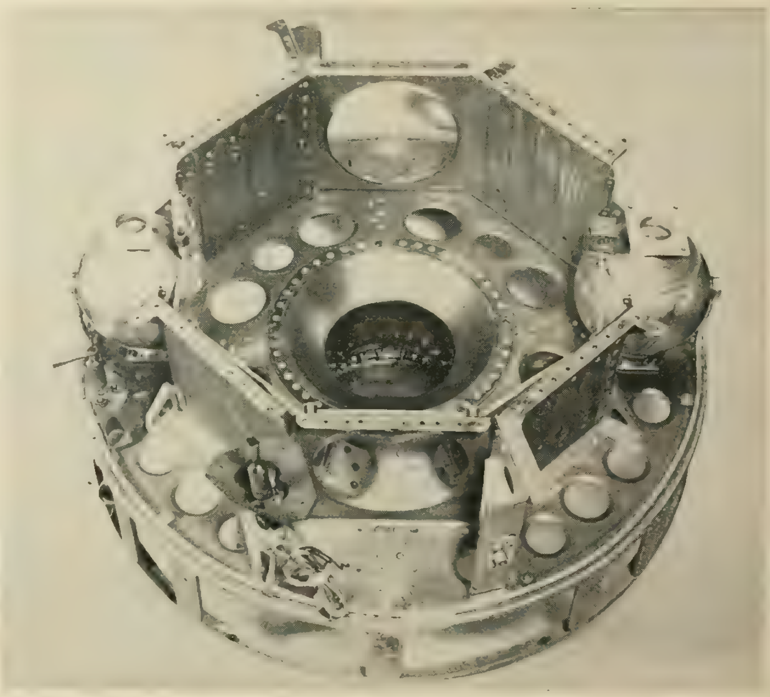
Removal of electrical power closes the valve and shuts down the reaction jets. The ground command system controls both the frequency of operation and pulse widths. The initial nominal thrust produced by the system is 2.8 lbs.; however, as propellant is consumed, the volume occupied by the pressurant gas increases and the pressure level drops. This reduces propellant flow rate and thrust to a minimum value of 1.1 lbs. as the peroxide supply is expended. The response time, or start time, as measured from signal to 90% thrust after warming pulses, is 37 ms nominal. Total impulse is 754 lbs.-secs. (steady-state).

- **Nearing station**—By Aug. 13, *Syncom II,* launched on July 26, had chalked up more than 152 hours of communications operation. The hydrogen-peroxide control system had reoriented the satellite's antenna and slowed its drift rate down to about 1½ degrees per day to the west.

It was expected to reach its desired station in space at 55 degrees west longitude on Aug. 15. At that point, the satellite was scheduled to be reoriented by the axial nitrogen jet. The nitrogen system was also to be used to maintain the synchronous orbit and the required longitude.

The nitrogen jets will be used to provide the control initially; in the event the nitrogen is completely expended, or if failure occurs, the peroxide system will then serve in that capacity.

The peroxide system is capable of many restarts during its one-year lifetime. Propellent valves and thrust motor assemblies used for *Syncom* are comparable to the Kidde designs which have been used successfully on the reaction control system of the *Scout* launch vehicle and are also being used on the Air Force *Asset* vehicle. ■



KIDDE'S hydrogen-peroxide jet control system shown mounted in Syncom II.

Tests conducted by Republic Aviation Corp., Farmingdale, N.Y., under a contract awarded by International Latex Corp., developer of the suit for United Aircraft's Hamilton-Standard Division, NASA's prime contractor.

The other day, at Republic Aviation's Life Science Labs, where we are running the life-support and mobility tests on the Apollo Space Suit, somebody asked the guy in the suit how the tests are going, and he said:

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Lockheed Boosting Its NASA Agena Output

by Robert Lindsey

SUNNYVALE, CALIF.—Lockheed Missiles & Space Co. is gearing up to produce *Agena* vehicles for NASA missions in 1964 at a rate of one a month.

Program managers here say they expect two factors to encourage success in the accelerating and wide-ranging use of *Agenas* in NASA programs: the long experience with the spacecraft in Air Force and previous NASA operations; and the increasing standardization of all spacecraft systems, epitomized by the standardized *Agena-D*.

Although development is continuing on several improvements to the spacecraft, Harold T. Luskin, head of the LMSC Medium Space Vehicles Division, told MISSILES AND ROCKETS: "We're not looking for innovations; we're looking for reliability; and by total standardization, we're increasing reliability."

• **Record cited**—More than 100 *Agenas* have been launched since the first USAF *Discoverer* launch in the W117L program in February, 1959. Eight were used in NASA missions.

Although the total is classified, the number of Air Force *Agenas* successfully orbited is believed to be close to 70. More than 20 of the launchings were of the *Agena-D*. Most of the experience has been with *Thor* systems, but about one-third of the launches utilized *Atlas* boosters.

The NASA launchings have included two *Mariners*, five *Rangers* and an *Alouette*, a joint NASA-Canadian satellite program. Key difference between NASA and Air Force utilization of the *Agena* is that NASA employs it as a second-stage booster while the Air Force has used integrated payloads.

• **New designs**—NASA programs have required design of two new front ends for *Agena*, Luskin said. One is a rounded, conical shroud which is essentially a larger version of the shroud used on Air Force missions, and the other is a clamshell-configured shroud used for *Alouette* and *Nimbus*. The former system is used for all other NASA missions.

Agena-D's will be used for *Gemini;* block four of the *Ranger* program (television impact); *Mariner C;* the *Orbiting Astronomical Observatory (OAO);* and the *Polar Orbiting Geophysical Observatory (POGO.) Agena-B's* will be used in *Nimbus* and the *Eccentric Orbiting Geophysical Observatory (EOGO).*

Eleven *Agena-B's* are already constructed and available for NASA missions.

Although standardization is emphasized, each mission requires some customizing, even for those utilizing *Agena-D*, said D. R. Latham, Luskin's deputy.

Gemini is requiring the most customizing, he added. The customized features include:

—A secondary propulsion system.

—Modifications to the primary propulsion system to provide a minimum of five restarts.

—Electronics modifications for *Gemini* command and docking.

—A systems status panel which will tell *Gemini* astronauts whether the *Agena* is safe for docking.

—A yoke for the docking.

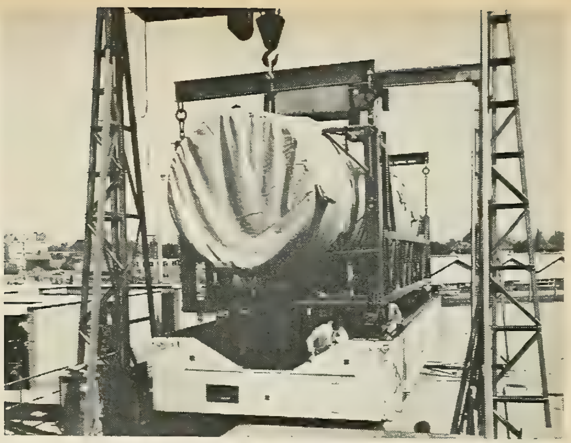
The vernier engines will have 216 pounds of thrust. Burning time for the primary engine will remain approximately 240 secs.

A small amount of the propellant will be used during injection, but Luskin noted that "the bulk of the propellant will be available for post-docking maneuvers."

Latham added: "The *Agena* has been labeled as a target vehicle in *Gemini*, but it could be called the target-maneuvering system or something like that. The real use of *Agena* will come after docking."

Luskin said the design modifications for *Agena* in the *Gemini* program are now essentially frozen. He noted that the Air Force has had a "major role all along" in design evolution.

• **New demands**—*Mariner C* flights according to Luskin, will require a "fantastically more difficult job in terms of guidance and reliability" than previous uses of *Agena* in NASA programs, because the greater distances of interplanetary flight will amplify small errors enormously. He said requirements for guidance timing, overall reliability and accuracy are "substantially" more than in the *Mariner* fly-by of Venus. ■



First Blue Streak Arrives in Australia for ELDO Use

To undergo static firings in preparation for March '64 launch; complete ELDO vehicle seen in '66 flight

by Bernard W. Poirier

EUROPE'S FIRST *Blue Streak* has arrived at Australia's Woomera Rocket Range in preparation for the initial flight test of the first stage of the European Launcher Development Organization space rocket in March, 1964.

The de Havilland-made *Blue Streak DA* (D for development) left the London Docks as deck cargo in a special 65-ft. transportation container weighing a total of 26 tons which was hauled overland from the Stevenage, England, factory.

A spokesman of de Havilland's parent organization, Hawker Siddeley Dynamics, said *Blue Streak DA* arrived in Adelaide, Australia, on July 15 and was taken by road to the Weapons Research Establishment Range at Woomera.

There the launcher pad equipment is almost identical to that of the Ministry of Aviation's rocket establishment at Spadeadam, England. *DA* and Spadeadam ground equipment were checked out together in April and May of this year.

At that time, *Blue Streak DA* was given static firings under completely representative launch conditions. The results were monitored by Rolls-Royce and de Havilland checkout equipment.

At Woomera, *DA* will undergo static firings at full-rated thrust. Everything at the complex is reported ready—liquid oxygen, kerosene fuel lines, liquid nitrogen, gaseous nitrogen, lubricating oil, vehicle electric power supplies, cold air, propulsion-bay heating, and water for fire fighting.

The ELDO programmed countdown lasts about six hours, with the last five minutes automatically sequenced to ignition. Some *Blue Streak* countdown programs in the past had up to 10 minutes automatically sequenced.

Upon arrival of another *Blue Streak*, scheduled for transport in late 1963, *DA* will be moved aside, but will be used to train ELDO launch crews.

- **ELDO progress**—The new vehicle, arriving at the turn of the year, will be flight-tested in March. Like *DA's*, its tanks will be pressurized with gaseous nitrogen to 5 psi during the entire six-week sea-and-land journey.

ELDO says its launcher will be the "first" large European space rocket. It will, the secretariat says, insure (1) the highest probability of success in terms of time and available state of the art, (2) the most versatile possibilities for potential users, and (3) growth potential after initial development.

ELDO reports that work on *Blue Streak* and the French second stage is well advanced. Trials of the second stage are scheduled to take place at Colomb-Béchar during 1965. These will include compatibility flights with the German third stage.

"Finally," an ELDO spokesman adds, "Launchings of the complete ELDO vehicle will take place at Woomera in 1966."

Australia makes no direct financial contribution to ELDO. Its share is taken up by placing at ELDO's disposal the Woomera range and support facilities for trials of the first stage and of the complete launcher.

Contributions and program responsibilities in ELDO's first Five-Year Plan are shown in the table below. ■

	CONTRIBUTION (Thousands of dollars)	PROGRAM SCOPE (Area of responsibility)
Australia	—	Woomera Range and facilities
Belgium	$ 5,586	Equipment of down-range guidance stations
France	$46,904	Second stage of launcher
Germany	$43,139	Third stage of launcher
Italy	$19,168	First series of satellite test vehicles including their instrumentation
Netherlands	$ 5,174	Long-range telemetry and associated ground equipment
United Kingdom	$76,029	*Blue Streak*
TOTAL	$196,000	First ELDO 5 yr. plan

(Infrastructure share of Germany was reduced .01 to 22.01%, and Britain's increased proportionately to 38.79%, since the last M/R report. For percentage breakdown, see M/R, July 29, 1963, p. 124.)

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Westinghouse Outlines Design of Gemini Radar

BOSTON—Performance and design details of the cooperative *Gemini-Agena* rendezvous radar system show that the system has a consistently large signal-to-noise ratio even at maximum radar ranges.

William W. Quigley, of Westinghouse Electric Corp.'s Air Arm Division, builders of the system for *Gemini* prime contractor—McDonnell Aircraft Corp.—reported last week that "with a peak transmitted power of only 1,150 watts—and an average power of less than 2 watts—an S/N ratio of at least 17 db is obtained." This gives virtually total probability of detecting each received pulse, he pointed out, even with a non-range-gated system such as the WEC design.

First production version of the *Gemini* radar system is slated for delivery to NASA later this summer (M/R, June 24, p. 25).

Quigley spoke at the American Institute of Aeronautics and Astronautics' Guidance and Control Conference, held at Massachusetts Institute of Technology.

The well-attended three-day meeting attracted about 650 persons to the MIT campus here. Heavy emphasis was placed upon orbital rendezvous equipment and techniques.

- **"Novel combination"**—The *Gemini* radar system, as Quigley described it, is a transponder-augmented pulsed radar which uses pulse round-trip-time for range measurements and interferometer techniques for angle determination.

Use of other radars, such as pulsed Doppler, CW, and FM/CW was considered but these were dropped either because they failed to meet range data needs or bcause they involved excessive weight and complexity. Availability of an on-board *Gemini* digital computer to tie the radar to the spacecraft inertial platform also obviated the need for a heavy gimballed antenna system. Instead, WEC uses a lightweight four-element fixed-array antenna.

The radar uses what Quigley described as "a novel combination of standard design techniques" to provide accurate digital angle and range data to the *Gemini* computer from 250 n. mi. to 500 ft., and accurate analog range-and-range-rate data for astronaut display from 300,000 ft. to 20 ft.

Also, a direct digital command link between *Gemini* and *Agena* has been integrated within the radar, using the same receiver channel, which gives the astronauts direct space-to-space control of *Agena* during rendezvous. This will complement the extensive ground-based *Gemini* digital command system. (M/R, July 22, p. 32).

The radar, operating at L-band, uses a non-coherent pulse transmission, a series of 1-microsecond pulses at a pulse repetition frequency (PRF) of 250 pps, radiating from an antenna which has a 3-db, solid-angle coverage of 70 deg. The transmitting antenna is one of four which make up the array; the other three—for azimuth, elevation, and reference—serve as receivers in the interferometer system.

With pulses received and verified, the *Agena* transponder is activated and 6-microsecond replies are transmitted. The reply, offset in frequency and time-delayed, allows the radar to discriminate transponder reply and reflected "skin" signal, cutting down on tracking error "glint" noise. Quigley says it also allows close-in tracking—the delay between transponder response and radar transmission is long enough so that at zero range the reply pulse will arrive after receiver blocking has cleared.

- **Antennas**—Using the interferometer techniques, target line-of-sight (LOS) is arrived at by measuring the difference in RF path length to the three receiving antennas, which are located on orthogonal lines within the roll reference plane. A pair of antennas establishes azimuth and elevation direction, with a reference antenna common to each pair.

The outputs of the two antennas, Quigley says, are applied to a differencing circuit. When the target is on boresight, there is no phase difference between signals, and the circuit output is zero. A phase dither arrangement is added for information as to which side off-boresight targets are on.

The phase shift of one channel, Quigley explains, is stepped between two values at a rate synchronized to the PRF. A target off boresight results in an amplitude modulation of the difference signal at a frequency which is half the PRF. Comparing this modulation with the dither reference signal yields an error signal with the required sense information. In essence, when the electrical phase shift between the two RF signals arriving at the antennas is known, the bearing angle may be found.

The azimuth and elevation antennas used in the system are circularly polarized, built as Archimedian spirals printed directly on epoxy boards. They are rotated, to obtain receiver phase shift for angle tracking, by low-torque instrument servo motors without a gear train. This eliminates the usual servo non-linearity problems, says Quigley, and gear train backlash is minimized. Essentially, the rotated circularly polarized antenna serves as its own linear phase shifter. With this scheme, WEC reports, design techniques have been evolved to obtain on-axis ellipticity ratios of 0.2 db, giving errors due to ellipticity of less than one milliradian.

The transponder antenna system employs both a dipole array—which gives a doughnut-shaped antenna pattern for omnidirectional coverage in the azimuth plane—and two spiral antennas to fill in at near ranges. The dipole array is actually two stacks of dipoles, each stack containing four small, canted dipoles.

Transponder antenna switching circuitry switches between dipole and spiral antennas automatically when the signal decreases below the sufficient amplitude detector level as a result of LOS change. Also, Quigley points out, if the radar pulses should be interrupted for any reason, the switching circuitry will sample each antenna alternately until the signal reappears, but if loss lasts for more than 30 secs. the transponder returns to standby mode.

- **Time sharing**—To eliminate the need for two receiving channels, one for each axis, and to keep the information rate as high as possible, each received pulse is time-shared to measure range on each pulse and also to obtain one bit of elevation and one bit of azimuth angle data on each pulse. Special solid-state microwave switching with a high order of phase stability and switching times of a fraction of microsecond have been developed for the RF antenna switching involved, WEC reports.

The analog range readout to be displayed to the astronaut is measured with a "novel sweep generator," which Quigley says gives greater sensitivity at short ranges. The system employs a sweep having three discrete range intervals, with different slopes.

The analog range-rate output is obtained through operational differentiation of the analog range voltage. The same logic circuitry that changes the range sweep slope changes the differentiator gain in this operation.

The more precise digital readout is obtained by using a high-speed digital counter and a 10-mc crystal oscillator for a time standard. With digital averaging of four counts, the system is reported to be capable of measurement accuracies within 0.1% of range for vehicle separations up to 250 mi. For astronaut display, the received data indicator is a panel meter having multiple pointers and integrated scales. Indicated range is zero to 300,000 ft., and range rates are —100 to +500 ft./sec.

For very important close-in measurements, a vernier range-rate meter is included. It permits measurements of 1 ft./sec. increments in the range of —5 to +5 ft./sec. Range indication is made in quasi-logarithmic form, made possible by use of the analog sweep generator, consisting of three equal-length contiguous linear scales. ■

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In addition, flexible carbon and graphite are being used as randomly-oriented fibers, chopped cloth, tape—and recently as yarn—to reinforce plastics.

For complete information on solid or flexible carbon and graphite, call National Carbon.

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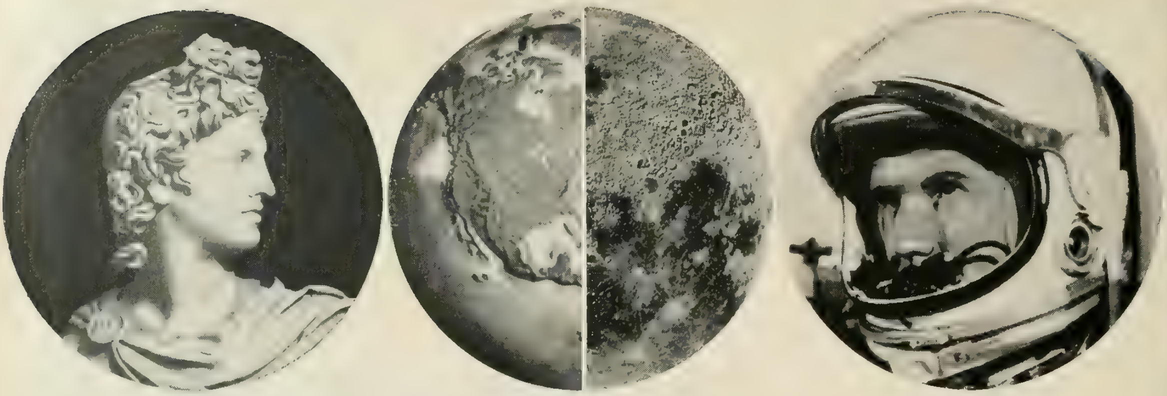
Division of Union Carbide Corporation, 270 Park Avenue • New York 17, N. Y.
In Canada: Union Carbide Canada Limited, Toronto
UNION CARBIDE

Circle No. 8 on Subscriber Service Card

GENERAL ELECTRIC ENGINEERING OPPORTUNITIES



ACT NOW FOR ASSIGNMENTS ON PROJECT APOLLO

> *"The requirement for the Integration and Checkout program arises from the unique characteristics . . . of Apollo . . . which distinguishes it from other projects. These include (1) the serious consequences of failure as measured in terms of national prestige, human life and cost; (2) the complexity . . . in terms of the technology required and the numbers and types of industrial contractors involved; and (3) the long period of operations in the space environment with no significant maintenance or repair possible."*
>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

General Electric's Apollo Support Department has been selected to assist NASA in the integration support, checkout and reliability assessment of the Apollo system. Without doubt, it takes an unusually mature and competent man to perform under the realization that his individual work can be of significant importance to such a program.

If you are the kind of person who thrives on such responsible work, there's a place for you with General Electric. We've already put together the most impressive team ever assembled in the General Electric Company for this program . . . however, there are *many* opportunities still available to the *right* men. From the listings below you can determine your own opportunities. **Contract Programs:**

CHECKOUT . . . work consists of two distinct parts. First, a continuation of current engineering study efforts to provide NASA with checkout systems analysis, standardization studies, an integrated space vehicle checkout system specification, studies of test procedures, the application of advanced checkout techniques to Apollo, and system checkout engineering support at NASA field centers. Second, provision of checkout equipment to be included within the integrated launch control and checkout system.

RELIABILITY ASSESSMENT . . . effort includes assisting NASA in assessing overall mission reliability and safety levels, implementing a reliability and failure data system, and reviewing reliability and quality procedures and controls.

INTEGRATION SUPPORT . . . assist in identification and documentation of equipment and procedure interfaces within the Apollo project. Studies of integration methods and their application to Apollo including configuration control, and data handling.

Engineering experience required in: SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

☐ **Complex Systems Design**
☐ **Guidance Control Systems**
☐ **Telemetry Systems**
☐ **Electronics Packaging Design**
☐ **Logic Design**
☐ **Human Factors**
☐ **Systems Engineering**
☐ **Cryogenics**
☐ **Engineering Writers**
☐ **Computer Engineering**
☐ **Computer Programming**
☐ **Data Processing Display**
☐ **Circuitry & Circuit Design**
☐ **Data Analysis**
☐ **Launch Facilities Systems**
☐ **Instrumentation & Simulation Systems**

IF YOU ARE THE CALIBRE OF ENGINEER WHO CAN SHOULDER THE RESPONSIBILITIES THESE JOBS ENTAIL, WE HAVE IMMEDIATE OPENINGS IN HUNTSVILLE, ALABAMA; CAPE CANAVERAL, FLORIDA; DAYTONA BEACH, FLORIDA; AND HOUSTON, TEXAS.

Write today to: Mr. P. W. Christos, Apollo Support Department, General Electric Co., Support Building, Room 73-R, P.O. Box 2500, Daytona Beach, Florida. (Your inquiry will be held in strict confidence. Please include your salary requirements.)

APOLLO SUPPORT DEPARTMENT
A Department of the Command Systems Division

GENERAL ELECTRIC

An Equal Opportunity Employer

Mergers and Acquisitions

Litton Industries, Beverly Hills, Calif., has purchased the Aerospace Research and Engineering departments of General Mills. The General Mills departments have been doing advance research and development in upper-atmosphere physics, microbiology, communications and materials. . . . *International Telephone and Telegraph Corp. has reached agreement with John J. Nesbitt, Inc., Philadelphia to buy assets of that company. Nesbitt produces air conditioning, heating and ventilating equipment.* . . . Microlab, Livingston, N.J., electronics firm has acquired Bogart Manufacturing Corp., Brooklyn, N.Y., makers of wave guides, high power terminations, high power T-switches, and other microwave components. . . . *Gulton Industries, Inc., Matuchen, N.J., electronics firm, has purchased Servonic Instruments, Inc., of Costa Mesa, Calif. Servonic manufactures potentiometer type transducers for missile/space, aircraft and underwater vehicles.*

New Firms and Divisions

Talon Adhesives Corp. has been formed in Kearny, N.J., to manufacture epoxy paste and solvent-dispersed types of adhesives for electronics applications. . . . *Tek-Counsel, Inc., has been formed in Chevy Chase, Md., as missile/space industry consultants in marketing, product planning and analysis, technical advertising, customer contact, proposal preparation and presentation, and contract negotiation in the fields of telecommunications and data instrumentation.* . . . Sigmund-Cohn-Pyrofuze, Inc., has been established with headquarters in Dallas to unify products engineering for Sigmund Cohn Corp. and its affiliate, Pyrofuze Corp., both of Mount Vernon, N.Y. SC manufactures precious metal products and electroplated wire; Pyrofuze makes bi-metallic products with applications as rocket fuel additives, fire transferral devices and bridge wires. . . . *United ElectroDynamics, Inc., Pasadena, Calif., has combined its United AeroSpace and United Testing Laboratories Div. to form the AeroSpace Div. as part of a major reorganization to return to profitability.*

International

Standard Telephones and Cable, Ltd., British affiliate of International Telephone and Telegraph Corp., has acquired P. J. Fox, Ltd., a British designer and manufacturer of precision potentiometers. Fox is to become part of STC's electro-mechanical division based at Harlow, England. . . . *Scientific Data Systems, Santa Monica, Calif., manufacturer of digital computers, digital system components and logic modules, has concluded an agreement whereby Compagnie Generale d'Electricite in Paris will market SDS products in Europe and Great Britain. CGE is to purchase more than $2 million worth of SDS equipment during the first 18 months of the contract, and has an option to manufacture as a licensee. SDS currently markets in Japan under a similar agreement with F. Kanematsu & Co., Ltd.* . . . Amphenol-Borg Electronics Corp., Broadview, Ill., has acquired a minority interest in Dai Ichi Denshi K.K., a joint venture company formed in Tokyo to manufacture electronics.

Industry Facilities

Air Reduction, Inc., New York, will build a 1,000 ton-per-day gaseous and liquid oxygen, nitrogen and argon plant adjacent to NASA's Michoud aerospace fabricating center in New Orleans. The $8-million facility will use barges for transporting liquified gases through the intracoastal waterway, on which it is to front, as well as up the Mississippi River. Airco plans to service clients as far as 700 miles away, in addition to the Michoud facility. . . . *Belock Instruments Corp., New York City, has opened a new 3,000-sq.-ft. electro-optical R&D laboratory. Belock manufactures missile/space electronics, and electro-mechanical equipment.* . . . Fairchild Stratos Corp. is moving its Electronic Systems Div. from Wyandeanch, N.Y., to new company facilities in nearby Bayshore, N.Y. The new facility is designed especially for electronics development work. The old plant will be leased to Grumman Aircraft Engineering Co. . . . *Lockheed-California Co., Div. of Lockheed Aircraft, plans to open a new electromagnetic laboratory in December to develop antennas and components for advanced space and aircraft communication-detection systems. The $750,000 facility will contain 25,000 sq. ft. of space.* . . . Lear Seigler, Inc., Grand Rapids, Mich., has broken ground on a $1.3-million administration building for its Instrument division. The 100,000-sq.-ft. facility will complete a 65-acre company aerospace complex. . . . *Moog Servocontrols, Inc., East Aurora, N.Y., makers of steering controls for missiles, rockets and aircraft, has opened a new 40,000-sq.-ft. plant and office building in the Gardenville Industrial Park, Cheecktowaga, N.Y.*

Company Representatives

Milgray/Washington, Hyattsville, Md., has been appointed an authorized distributor for the Semiconductor-Components Div. of Texas Instruments, Inc., Dallas. . . . *Welco Magnetics Corp., San Francisco and Inglewood, Calif., has been named California-Arizona sales representative for Arnold Magnetics Corp., Los Angeles. Welco will handle Arnold's line of toroidal winding machines.* . . . Henschen, Jenson and Co., Huntington Woods, Mich., and Cordex Electric Co., Montreal, Quebec, have been appointed representatives for National Connector Corp. of Minneapolis. HJ is to cover Michigan and central Indiana and Cordex, eastern Canada.

How high is your goal?

Ours are out of sight—in the labyrinth of space. But your opportunities are a tangible reality, here and now at North American's Space and Information Systems Division.

CRITERIA AND REQUIREMENTS
Interpret project requirements; develop environmental and reliability criteria, program plans, objectives, apportionments, control and assurance provisions.

DESIGN ANALYSIS
Assist in the development of reliable design concepts; conduct failure mode and worst-case analysis; perform redundancy and trade studies, and review designs and specifications.

TESTING
Develop reliability qualification and verification test plans; write test procedures, schedule and monitor tests, evaluate results, and prepare recommendations.

ADVANCED PROJECTS
Analyze complex reliability problems related to advanced design concepts; develop advanced reliability techniques; establish reliability criteria, procedures, specifications and standards.

These are professional engineering positions. A technical degree and several years of applicable experience is desired.

Interested? Please Contact:
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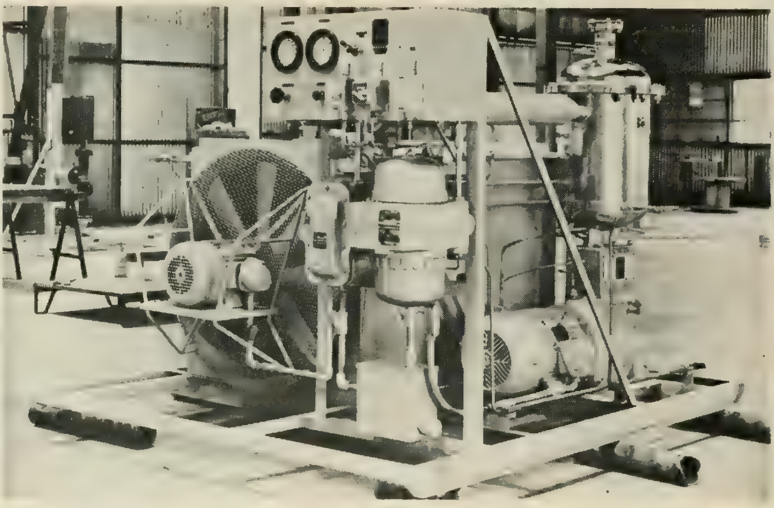
DOWNEY, CALIFORNIA

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION



New Product of the Week: *Recharger Unit*

A skid-mounted high pressure liquid hydrogen conversion system has been developed by Cryo-Sonics, Inc. The system utilizes ambient air to vaporize high-pressure 6,000-psig hydrogen at a flow of 24,000 SCFH. N.P.S.H. is 20 to 50 psig, and is used in the aerospace field, ground support, refinery and chemical applications.

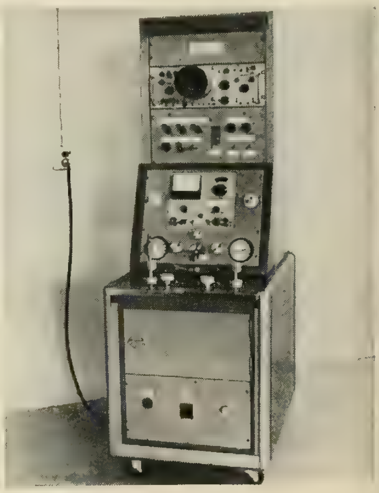
The system is built to MIL and AN specifications and features durable construction to withstand rugged usage in the field, and electrical requirements are 21 kw.

Circle No. 225 on Subscriber Service Card

Induction Plasma Torch

A high-temperature torch has been developed by TAFA Div., Humphreys Corp., which permits heating a variety of gases to between 3,000 and 15,000° F. This torch inductively heats gas, much as an iron bar is heated by commercial induction heating equipment. The gas is first made electrically conductive by sparking, and then the power supply is coupled to the conductive gas through a transformer-type coil constructed within the torch shown in the attached picture which shows an air plasma. The device can be used to heat air to temperatures of 3,000 to 10,000° F on a continuous basis without contamination or torch deterioration.

Circle No. 226 on Subscriber Service Card



Frequency Response Unit

A pressure transducer frequency-response analyzer, Model FRA-101, utilizing a piezoelectric high-frequency pressure modulator has been developed by American Aerospace Controls, Inc.

The unit is capable of generating input sinusoidal hydraulic pressures of 0 to 500 cps against an adjustable reference pressure of from 0 to 2,000 psig, with a modulation of up to ±10% of the reference pressure. Amplitude ratio as well as transient response are observable directly on an oscilloscope; phase shift is read out on a graduated dial.

Circle No. 227 on Subscriber Service Card

Low Torque Coupler

A coupler capable of carrying 65 data channels across a ±16 degree angular rotation is being marketed by Aeroflex Laboratories, Inc.

Rotation up to ±40 degrees can be achieved by reducing the number of data channels or increasing the size of the unit.

In the coupler, flat beryllium-copper springs are attached between a stationary and a rotating disc. Deflected to a U-shape by light mounting plate pressure, the springs are free to "roll" along their longitudinal axes as the plates rotate.

Circle No. 228 on Subscriber Service Card

Semiconductor Test Set

A semiconductor test set has been developed by the Westinghouse Aerospace Electrical Div. The unit is self-contained, requiring no supplementary equipment. The bench-mounted cabinet incorporates instrumentation, loading devices, power supplies, and a temperature indicating device with a variable-setting temperature safety control.

The instrument tests power diodes, power zener diodes, power transistors and silicon-controlled rectifiers. Capable of applying forward currents from 10 milliamperes to 500 amperes, the set provides base and gate drives from 10 milliamperes to 10 amperes.

Circle No. 229 on Subscriber Service Card

Rotary Coupler

Adams-Russell Co., Inc. has developed a multi-channel rotary coupler. The Model IV is designed for low operation over a broad range of frequencies, and for speed through 3,600 rpm. The standard model consists of four individual couplers, each of which can be independently specified for HF, IF or VHF operation.

Typical electrical specifications for coupler options: coupling, contactless; insertion loss, less than 1 db at all options; characteristic impedance HF option or IF option, 75 ohms, VHF option, 50 ohms; WOW modulation, 0.1 db max. at all options.

Circle No. 230 on Subscriber Service Card

Tropospheric Scatter System

General Electric Communication Products Dept. is marketing a tropospheric scatter system for short-haul telecommunications.

Block-built and furnished in fixed station and transportable "heli-hut" versions, the equipment uses a 500-watt transmitter with dual diversity reception, and has single voice channel capability.

Circle No. 231 on Subscriber Service Card

CHIKSAN swivel joints engineered for your applications in aerospace systems

Missile Fueling: Swivel joints and assemblies to handle cryogenic liquids and fuels in ground loading and topping hose.

Aircraft Systems: Compact, lightweight assemblies of proved reliability available with end connections conforming with AND and MS standards.

Ground Handling Equipment: Swivel joints and assemblies to handle hydraulic, pneumatic and fuel systems on launching vehicles and missile transporters. Units for rotation in 1, 2 or 3 planes in widest variety of metals, pressures and temperatures available.

Ground Support Equipment: Loading arms and flexible transfer assemblies for handling LOX, N_2, H_2, JP fuels, H_2O_2 and hot gases.

Specifications: Corrosion resistant steel, nickel, brass, aluminum, bronze and other metals available for temperatures ranging from −320° to 600°F, pressures from 28″ vacuum to 15,000 psi in sizes ¼″ to 16″.
For more information send for Chiksan Aircraft and Aerospace Catalog.

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Circle No 9 on Subscriber Service Card

ENGINEERS

solve tomorrow's tactical weaponry problems at

HONEYWELL

Honeywell's Ordnance Division in suburban Minneapolis recognizes the importance of tactical armament in tomorrow's weaponry and is seeking seasoned engineers who are no longer challenged by **today's** state-of-the-art.

The division's growing engineering department is working, under contract, with key agencies in all services to conceive and design systems and hardware for ground launched weapons, helicopter and aircraft armament, reconnaissance and surveillance systems.

To solve the multiple and complex technical problems of new weaponry, the Ordnance Division must immediately expand its capabilities in target identification (radar, IR, TV), small rocket propulsion, small rocket and projectile guidance, stability and control, fuzing and many other disciplines.

TODAY WE HAVE KEY OPENINGS IN THE FOLLOWING AREAS:

GUIDANCE AND CONTROL... Staff and senior positions for individuals with BSEE and/or MSEE and experience in guidance, stability and control of tactical missile systems. Individual must perform systems analysis and synthesis of analog and digital control methods and be capable of evaluating all automatic feedback control systems.

FIRE CONTROL AND BATTLEFIELD RECONNAISSANCE... A senior staff engineer with BSEE and/or MSEE and 7-10 years' experience in systems concepts analysis of optical sensing and ranging and TV scanning for battlefield reconnnaissance and surveillance and fire control applications. Strong background in pulse circuitry, power requirements, data links and displays necessary.

DYNAMICS, AERODYNAMICS AND STRUCTURAL ANALYSIS ... Senior systems engineers with BS and MSAE or ME and 3-8 years' experience in missile static and dynamic stability analysis, trajectory analysis, rigid and flexible body dynamics, and structural analysis and design.

OPERATION ANALYSIS ... Staff and senior positions for individuals with MS or PhD in appropriate discipline. Experience required in one of the following: 1. Weapons effectiveness and feasibility analysis; 2. Weapons cost and economic environment analysis; 3. Human factors of tactical weapons man-machine relationships.

IN ADDITION TO THE ABOVE AREAS, IMMEDIATE CAREER OPPORTUNITIES ARE ALSO AVAILABLE IN:

Servo Analysis and Synthesis
Solid State Circuit Design
Explosive Device Design
Fluid Systems Design
Wind Tunnel Test
Quality Control (ME)
Small Mechanism Design
AE, ME, & EE Design Evaluation

INTERESTED?

To arrange an interview call collect or write:

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Circle No. 10 on Subscriber Service Card

Modular Signal Generator

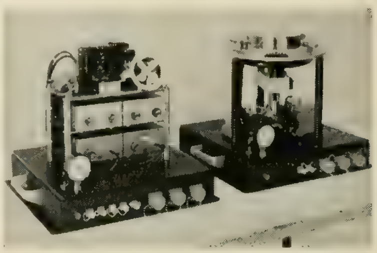
A line of modular signal generators and signal sources operating in the 3,800 to 21,000 mc range is available from Polarad Electronic Instruments. The signal generator modules offer digital frequency readout with ±0.5% accuracy and calibrated power level indicator and attenuators. Power outputs range from 3 dbm to —127 dbm with ±2 db accuracy. Internal modulation: 400-1,200 cps square wave, 400-1,200 cps FM sawtooth with continuously adjustable sweepwidth to at least ±5 mc from center frequency. The signal source modules are identical to the signal generator modules except for the calibrated power output, attenuator, and indicator.

Circle No. 232 on Subscriber Service Card

Magnetic Recording Drum

Low frequency response and constant output amplitude with variable speed operation are provided by the Model 6037 analog magnetic recording drum available from Instrument Systems Corp.

The Model 6037, with a frequency range of 5 to 2,000 cps, is equipped with Hall-effect leads. It can be applied to signal processing, correlation systems, data storage and signal delay. It is designed for use in precision analog systems as well as applications where signal delay or storage time is varied by changing drum velocity rather than head position. A servo drive on the drum shaft permits systems synchronization or signal follow-up.



Circle No. 233 on Subscriber Service Card

Attenuator

Somerset Radiation Laboratory, Inc. has developed a crystal-diode large X-band WR-112 waveguide switch modulator voltage-controlled attenuator, Model H410. It has a bandwidth of 400 mc centered at 8.9 gc, an isolation of 40.0 db. minimum from 8.7 gc to 9.1 gc, and a maximum insertion loss of 2.50 db. It can be switched in 10 nanoseconds and modulated from dc to 200 mc. An additional feature is a CW power-handling capability of 5 watts.

Circle No. 234 on Subscriber Service Card

Digital Axis Positioner

Datex Corp. has available a digital axis positioner, designated DAP-400, which provides an accurate and reliable means of automatically positioning axes of precision instruments such as X-ray diffractometers and spectrum analyzers. Designed for use with a card or tape reader, the unit provides positioning accuracy of 0.01° of the prime axis.

The device includes a Datex XDC-11 Encoderdyne with a vibration-free dc torque motor and an absolute digital count encoder. For highest accuracy and efficiency, motor direction and through-zero logic are employed.

The system outputs are an end-position operation signal and a positioning drive from a torque motor with 20 oz.-in. peak torque, capable of driving a prime axis at approximately 1°/sec. with a resolution of 0.01°. Running torque is 50 oz.-in. at 30 rpm or 1°/sec. The end position signals are in the form of 0 to —1volt dc for true and —18volt dc for false.

Circle No. 235 on Subscriber Service Card

Electrostatic Voltmeter

The electrostatic voltmeter made by Trub, Tauber and Co. measures either ac or dc voltages in the range from 0 to 100,000 volts.

The units have the fundamental feature that they provide accurate indications on both direct current and alternating current. They are suitable where only small powers are available or where the voltage is too high to allow a measurement to be made with other types of instruments.

Circle No. 236 on Subscriber Service Card

Tone Filters

A line of high- and low-Q tone filters is currently being introduced by Control Science Corp. These filters and related discriminators employ the classic circuit in which a frequency determining network becomes the feedback arm of an operational amplifier. This configuration is called an "active" filter and has greatest application at the low end of the spectrum. Normally, filters are supplied with output voltage equal to input; however, the gain is adjustable in production which enables the user to specify input and output voltages over a wide range.

Control Science's tone filters offer the following design improvements: improved stability over a wide temperature range, narrow bandwidths (Q up to 500), very small total package, very low power drain, design flexibility.

Circle No. 237 on Subscriber Service Card

Space Cable Systems by Prodelin

Photo courtesy General Dynamics/Astronautics

Spir-O-line

aluminum-sheathed coaxial cables
and matching Spir-O-lok connectors

Prodelin's Spir-O-line coaxial cable systems are helping to supply information on spacecraft performance as an integral part of complex communications equipment.

On the Atlas-Centaur, built for NASA by General Dynamics/Astronautics, for example — a high-energy space vehicle destined to explore the solar system — Spir-O-line is connected to the tracking antenna of the Atlas booster and is also used in the Centaur telemetry-beacon-tracking systems. And in the Grand Bahamas, as part of the Azusa Mark 1 Tracking Facility, Spir-O-line helps track Mercury manned-capsule orbital flights.

We would be pleased to tell you more about these Prodelin products. Write for Catalog 591.

SPIR-O-LINE U.S. PAT. 2998472
SPIR-O-LOK U.S. PAT. 3010747

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Circle No. 11 on Subscriber Service Card

SOME 400 years ago, man's views concerning outer space were relatively simple—and obviously inaccurate. Today's space advances require an ever-increasing understanding of the physical and operational environments of manned space flight.

If *you* understand the environments of space vehicles and your background includes: guidance, navigation, celestial mechanics, flight control, attitude control, or space data processing and communications, you are invited to investigate the many career opportunities available at IBM.

The IBM Space Guidance Center, as guidance system integrator for the Gemini program, is developing the Gemini computer as well as improved docking/retrieving and re-entry techniques for NASA. The Center is also developing the guidance computer and related equipment for the Saturn program. IBM's on-board data processor for the Orbiting Astronomical Observatory is further evidence of the professional level of accomplishment by our space technology scientists and engineers.

Current studies at the IBM Space Guidance Center—in central New York State, bordering on the Finger Lakes vacationland area—include re-entry guidance and control, and space station data management and communications. IBM is an Equal Opportunity Employer.

Please write, outlining your major interests, professional experience, and qualifications. Your correspondence will receive our personal and confidential attention.

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Manager of Engineering Laboratory
IBM Space Guidance Center
Owego, New York

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Sine-wave Carrier Module

Deltime, Inc., is offering a unity gain sine-wave carrier module for magnetostrictive delay lines up to 4,000 μsec with 3-db bandwidth of 1mc. Delays up to 10,000 μsec at reduced bandwidths are available.

Amplitude modulated, frequency modulated and 100% pulse-modulated carrier waveforms can be delayed with an input output linearity of ±10% or better. Overall dynamic range is 20 db; output signal-to-noise ratio, 10:1 minimum for 100% pulse modulation; input level unmodulated 1 volt across 600 ohms; power supply +12v dc at 50 ma, −12v dc at 55ma. Operating temperature range 0-55 C.

Overall dimensions of the MC-1 are $\frac{7}{8}$ x $3\frac{1}{2}$ x $5\frac{5}{16}$ in.

Circle No. 238 on Subscriber Service Card

Laser Detector

Korad Corp., a subsidiary of Union Carbide Corp. is marketing the "Korad" Model K-D1 detector, a power-sensitive photon radiation transducer for measuring and monitoring laser output and the output of other light sources.

The device has a rise time of 0.3 nanoseconds. Designed for a wide range of photo detection application, the unit can be used in giant pulse laser work and can also serve as a trigger generator or demodulator.

Absolute power measurements from 1 watt to 10^{10} watts, and energy measurements from 10^{-8} to 10^{8} joules are typical.

Circle No. 239 on Subscriber Service Card

Oscilloscope Converters

A series of plug-in units available from Pentrix Corp., covering 0.5 to 12,000 mc, converts standard oscilloscopes to spectrum analyzers without any modification to the oscilloscope. The combined instrument can be used as both an oscilloscope and spectrum analyzer.

These units offer low incidental FM of less than 800 cps, sensitivities down to −130 dbm, and dispersions to 60 mc.

Circle No. 240 on Subscriber Service Card

DC-to-DC Converter

A ringing-choke dc-to-dc converter designed for transistorized circuitry and photo-multiplier tubes is being marketed by Ferrodyne Corp.

The epoxy molded unit is constructed to MIL-T-27A (Class S, Grade 5) specifications. Typical input is 12-30v dc. Typical output is 600-1,200v dc at 50 microamp.

Circle No. 241 on Subscriber Service Card

High-Temp Gas Heater

A torch has been developed by TAFA Div. of Humphreys Corp. for continuous heating of oxidizing as well as reducing gases—such as air, CO, and CO_2—to temperatures in the range of 3,000 to 20,000° F. The unit operates at 8,000° F at a 25 kilowatt electrical input and uses a high-frequency power supply that inductively couples to and heats conductive hot gas.

Circle No. 242 on Subscriber Service Card

Atmosphere-Sampling System

Developed by the Isomet Corp., the 10-station automatic atmosphere-sampling unit is designed to draw gas samples from 10 different stations in any combination or order desired. The system and all components are designed to prevent introduction of impurities into the samples.

The sampling unit can be coupled with a suitable gas-chromatograph automatic sample injection valve. In this way, obtaining samples and injecting them into the chromatograph becomes completely automatic.

Circle No. 243 on Subscriber Service Card

Pressure Control Unit

United Electric Controls Co. is marketing a differential pressure-vacuum control for air, gas or liquid systems. The J21K maintains a system differential between two separate pressure or vacuum sources and transmits a signal (alarm, light etc.) and/or turns equipment on or off. Several models are offered with system differentials of 0 to 30 in. Hg vacuum: 0 to 6 psi, 0 to 40 psi, or 0 to 90 psi and others. Bellows material may be brass, phosphor-bronze, monel, or stainless steel. On-off operating differentials are from ½ ± 1/10 in. Hg to 3 ± 1 psi, depending on model.

Circle No. 244 on Subscriber Service Card

Pressurized Motor

A motor suitable for use in a hydrogen atmosphere is available from the Imperial Electric Co. The unit is unlike conventional explosion-proof motor construction where an explosion can be sustained within the motor without igniting the atmosphere. It is designed so that it can be sealed to permit purging and pressurization with an inert gas, such as nitrogen. While standard explosion-proof motors would have an extremely high loss of expensive nitrogen, the Imperial enclosure virtually eliminates leakage from the motor. The new hazard-proof motor is available in NEMA frames from 1 through 200 hp., squirrel-cage, wound rotor, and direct current.

Circle No. 245 on Subscriber Service Card

Rugged Solenoid Valves

The Monarch Machine Tool Co. plans to market a high-pressure, hydraulic solenoid valve for use in hydraulic systems with pressures to 1,000 psi. Body and stem are hardened steel, for non-stick, trouble-free service. The stem is ground and the body is precision honed to a maximum clearance of 0.0005 in. for minimum leakage. The valves are available in various body and stem designs for two, three or four-way O-ring manifold mounting applications. The coil is built to UL standards and is available in most a-c and d-c voltages and frequencies.

Circle No. 246 on Subscriber Service Card

Self-Starting Timer

A long-duration mechanical timer with a self-starting escapement has been developed by the Fairchild Space and Defense Systems division of Fairchild Camera and Instrument Corp.

Model F-466 is designed for 36-hr. operation. However, modification of the mainspring permits duration cycles as high as 300-500 hrs.

The timer, capable of withstanding shocks up to 20,000 g's in any direction, is specially lubricated to permit operation throughout a temperature range of −65° F to 160° F. The 240-per-minute beat rate can be adjusted to other values. Average beat rate can be held to an accuracy of better than ±½%.

Circle No. 247 on Subscriber Service Card

Hypergolic Valve

Moog Servocontrols, Inc., is marketing a hypergolic on-off valve for use in attitude-control systems of spacecraft, which consists of a single high efficiency torque motor driving a bifurcated-nozzle flapper valve. Fuel and oxidizer are metered by physically separate downstream nozzles.

One model is designed to be compatible with UDMH fuel and nitrogen tetroxide oxidizer. Internal leakage has been reduced to less than 0.5 cc per day by using a lapped metal-to-metal seal. External leakage is zero.

Circle No. 248 on Subscriber Service Card

Flexiscope

Bausch & Lomb has marketed a fiber optics inspection tool. The flexiscope image probe allows the operator to see internal areas of machinery, engines, and other intricate mechanisms without dismantling or destruction.

The flexiscope is a lightweight, compact unit designed to be held easily by hand. The two-foot probe can be inserted into any opening 0.5 in. or larger in diameter. When numerous obstructions cover the area under inspection, the tube can be bent to a radius of as little as 1.75 in., without damaging fibers or sacrificing image quality.

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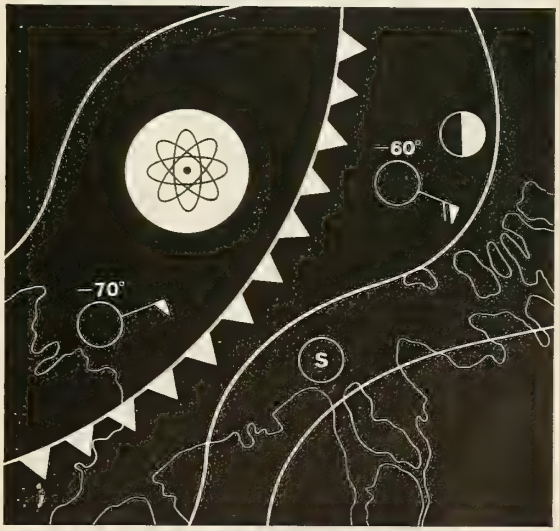

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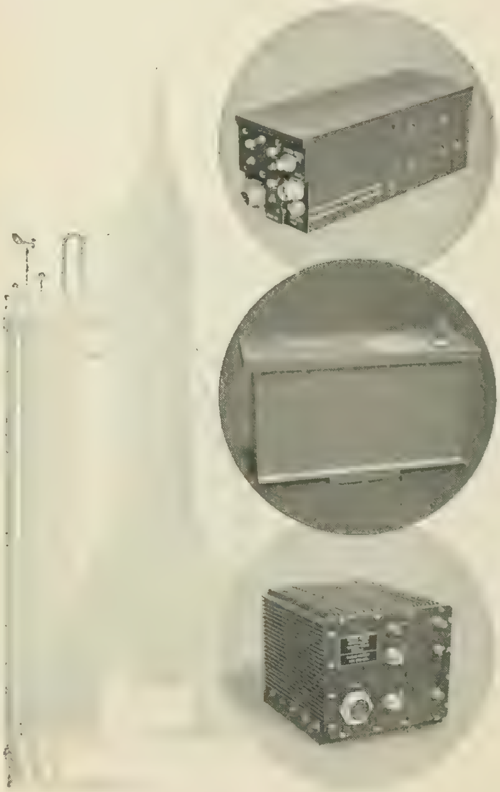

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—contracts and procurements—

AWARDS

AIR FORCE

$2,500,000—Ampex Corp., Redwood City, Calif., for high performance instrumentation recorders to be used at the Atlantic Missile Range.

$1,400,000—Litton Industries, Inc., Litton Systems, Inc., Woodland Hills, Calif., for production of guidance systems and related equipment.

$537,000—General Dynamics Corp., Electronics Div., Rochester, N.Y., for single sideband radio communications equipment to be used at missile installations.

$200,000—General Dynamics Corp., Fort Worth, Div., for an investigation of ways to improve the properties of metals by increasing both density and strength.

$120,000—Cubic Corp., San Diego, Calif., for detailed evaluation testing of AN/GSQ-29 multiple airborne target tracking system (MATTS) involving a five-month evaluation program; an error-computing program for MATTS computer; updating of MATTS transmitters, antennas, calibration techniques and power supplies; and preparation of equal-error contour maps of entire MATTS coverage area.

ARMY

$2,300,000—B. B. McCormack & Sons, Inc., and Bailes-Sey Contractors, Inc., for a joint venture to construct a railroad system for NASA on Merritt Island, Cape Canaveral, Fla.

$1,500,000—National Co., Malden, Mass., for development and production of direct range measuring systems.

$87,285—General Electric Co., Semiconductor Products Div., Syracuse, N.Y., for design, development and furnishing 50 tunnel diodes for phased array radar applications.

General Telephone & Electronics Corp., Sylvania Electric Products, Inc., Waltham, Mass., for a study of operational and performance requirements for satellite communications and a proposal for an integrated design and development plan for the initial control center of a worldwide military satellite communications system (ISACCC) (undisclosed amount).

NAVY

$27,200,000—Lockheed Aircraft Corp., Missiles & Space Div., Sunnyvale, Calif., for continued engineering services in connection with the *Polaris* missile program.

$170,000—Sylvania Electric Products, Inc., Semiconductor Div., Woburn, Mass., for continued development of silicon epitaxial technology for use in microelectronics and large-area semiconductor device structures.

NASA

$9,000,000—Bendix Eclipse, Pioneer Div., Teterboro, N.J., for manufacture and delivery of four prototype ST-124M stabilized platform systems and associated electronics—two for *Saturn 1B* and two for *Saturn V.*

$6,000,000—Radio Corp. of America, Data Systems Div., Van Nuys, Calif., for six RCA-110A ground computer systems used for checkout and launch of *Saturn* vehicles.

$1,300,000—Martin Co., Electronic Systems & Products Div., Baltimore, Md., for continued processing of data transmitted by the *Orbiting Solar Observatory.*

$500,000—Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., for the design, construction and installation of a large digital data system to be used at Plum Brook Station testing facility (near Sandusky, Ohio) to test *Centaur* rocket engines.

$350,000—G. T. Schjeldahl Co., Northfield, Minn., for three *Echo II* balloons—one to be used for static inflation tests; another employed in orbital flight and the third as a backup for the flight model.

$250,000—Ryan Aeronautical Co., San Diego, Calif., for fabrication of solar panel structures for the *Mariner* Mars fly-by vehicle.

$180,000—Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., for design and fabrication of two large data acquisition systems for the Manned Spacecraft Center.

$93,474—Razdow Laboratories, Inc., Newark, N.J., for the design and development of two optical servo pickups and for design, test and delivery of two direct-axis digital encoders (two contracts).

$91,426—Teledyne Systems Corp., Hawthorne, Calif., for research in advanced concepts in bio-technology, human analogs and bionics.

$71,853—General Electric Co., Missile and Space Div., Philadelphia, for out-of-core nuclear thermionic studies.

$60,100—Union Carbide Corp., Tarrytown, N.Y., for research on the growth of terrestrial plants in simulated and modified Martian environments.

$58,428—Dynatronics, Inc., Orlando, Fla., for improvements on the model ADC-2 analog-to-digital computer.

$50,630—Grumman Aircraft Engineering Corp., Bethpage, N.Y., for interaction of high energy gas molecules with solid surfaces.

$48,753—Martin Co., Research Institute for Advanced Studies, Baltimore, for a study to explain the basic mechanism by which green plants transform carbon dioxide and water into living tissue and oxygen.

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$40,000—**Hughes Aircraft Co.,** Culver City, Calif., for development and fabrication of flat electric cable for use in large missile boosters.

Philco Corp., Palo Alto, Calif., for a design study of an Advanced Solar Probe. Work to be done at the Ames Research Center, Moffett Field, Calif., (undisclosed amount).

Maremont Corp., Rocket Power, Inc., Mesa, Ariz., for production of an electrical energy beam which could serve as a powerplant for interplanetary space ships (undisclosed amount).

DOD

$1,300,000—**Western Electric Co.,** New York City, for electrical engineering work on an overseas communication system.

INDUSTRY

$2,300,000—**Sanders Associates, Inc.,** Nashua, N.H., for classified electronic equipment.

$1,800,000—**General Precision, Inc., Kearfott Div.,** Little Falls, N.J., from **Bendix Corp.'s Mishawaka Div.,** for the production of the STAPFUS (stabilized phase follow-up system) system as a part of the *Talos* missile guidance system.

$1,000,000—**Bell Aerosystems Co.,** Buffalo, N.Y., from **General Dynamics Corp.'s Astronautics Div.,** for follow-on production of reaction control systems for *Centaur.*

$750,000—**Milgo Electronic Corp.,** Miami, Fla., from **Control Data Corp.,** for input-output data subsystems for the Atlantic Missile Range real time computer system.

$400,000—**General Dynamics/Convair,** San Diego, Calif., from **Pan American World Airways, Inc.,** for a study and engineering design program leading to the development of an integrated telemetry receiving and recording station for the Atlantic Missile Range.

$200,000—**Precision Instrument Co.,** Palo Alto, Calif., from **United Technology Center,** for ten instrumentation tape recorders with a total capability of recording 600 channels of data during rocket test firing.

$115,000—**Fairchild Stratos Corp.,** Bay Shore, N.Y., from **North American Aviation,** for development of components for the waste management system for the *Apollo* spacecraft.

$100,000—**Regent Jack Mfg. Co., Inc.,** Downey, Calif., from **North American Aviation, Inc.,** for large, self-propelled, wheeled vehicles for installing F-1 rocket engines into the *Saturn V* space vehicle.

Gordon Enterprises, North Hollywood, Calif., from **Douglas Aircraft,** for an undisclosed number of camera tracking mounts (undisclosed amount).

F. J. Stokes Corp., CryoVac, Inc., and Pittsburgh-Des Moines Steel Co., from **United Aircraft Corp.,** for design and construction of an advanced man-rated high vacuum space chamber which will be used to test the space suit for Project *Apollo* and other space environment control equipment and systems (undisclosed amount).

Rohr Corp., Chula Vista, Calif., from **Lockheed Propulsion Co.,** for manufacture of motor case segment insulation for the first 156-in.-dia. solid propellant rocket motor to be fired next year (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Three items of rectifiers. Lot—IFB 7-4-13-102718-1. Bid opening 8-23-63.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Space vibrating capacitor (Reed) Electrometers in accordance with Specs No. 651-1274. Electronic package 4 in. x 6 in. x 1.5 in. Preamplifier housed in cylinder 2 in. diameter by 3 in. length. Gross weight not to exceed 1,000 grams—5 each. RFP SC-37-A. RFP due date 8-30-63.

National Aeronautics and Space Administration
Headquarters Contracts
Washington 25, D.C.

NASA is negotiating a contract with Technology Audit Corp., Washington, D.C., for a study of additional benefits that might be derived from a non-military navigation satellite system. RFP 10-1398. This notice is for information only. RFP not available.

Titan Procurement Div.
Missile and Propulsion Branch
Norton Air Force Base, Calif.

Production list 04-607-64-5 against existing contract AF 04(607)-7880 with Aerojet-General Corp., Sacramento, Calif., is in process. This procurement is for replenishing spare for SM-69 *Titan* propulsion system. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firm.

Purchasing Office
Range Procurement Div. (MTRC-3)
Air Force Missile Test Center
Patrick Air Force Base, Fla.

Design, fabricate, assemble, test and checkout of a ultra high frequency timing distribution system in accordance with Technical Exhibit SE/3532-1206—4 each. RFP 64-1012. RFP due date 9-6-63. Required delivery is 7 months after award of contract. This procurement will be accomplished in 2 phases: (1) Submission and evaluation of technical proposals without pricing to determine acceptability of supplies and services offered. (2) After evaluation of technical proposals, invitations for bids will be issued only to those firms having acceptable technical proposals. Copies of RFPs will be furnished to the extent available on a first received, first served basis. Bid opening date will be furnished at a later date.

Mauler Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

Procurement of a *Mauler* and *Redeye* weapon system familiarization course, 5 courses of instructions, deliveries required through June 1964. Deliveries to General Dynamics/Pomona, Pomona, Calif. Nonavailability of drawings and specifications adequate to support competitive procurement and lack of Mauler and Redeye weapons system equipment essential to supply to courses precludes award to other than prime contractor, General Dynamics/Pomona. Purpose of this synopsis is to make industry aware of subcontracting opportunities. All inquiries relative to subcontracting should be referred directly to General Dynamics/Pomona.

Bureau of Naval Weapons
Washington 25, D.C.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Maryland Shipbuilding and Drydock Co., Baltimore, Md., for services needed to evaluate *Typhon* equipment installed aboard the AVM-1. This notice is made for informational purposes only. C/N 6862-63. BuWeps Synopsis No. 41-64.

The Bureau of Naval Weapons contemplates entering into a contract with Northern Ordnance, Inc., Minneapolis, Minn., for the manufacture of one guided missile launcher system, Mk 10 Mod 6, for the *Terrier* missile. The above firm is the sole source for this proposed procurement. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting opportunities should contact the above firm direct, referencing C/N 0047-64. BuWeps Synopsis No. 40-64.

National Aeronautics and Space Administration
Headquarters Contracts
Washington 25, D.C.

NASA is negotiating a contract with LTV Research Center, Ling-Temco-Vought, Inc., Dallas, Tex., for an investigation of the effects of the Van Allen Belt electron radiation on capacitor type micrometeroid detectors. This action is the result of an unsolicited proposal. This notice is for information only.

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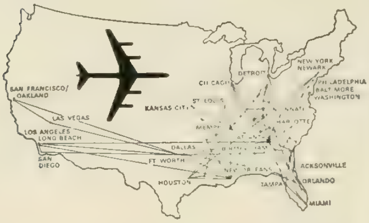

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Advanced degree plus at least three years experience preferred. For supersonic inlet design, development and test.

AIR BREATHING ENGINE PERFORMANCE
Advanced degree plus at least five years experience in air breathing engines preferred.

THEORETICAL AERODYNAMICIST
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GENERAL DYNAMICS | FORT WORTH GD

—names in the news—

Robert E. Worcester: Appointed director-plant facilities and land management for Varian Associates, Palo Alto, Calif.

Edward J. Carney: Named manager of advertising and sales promotion for the Distributor Products Div. of International Telephone and Telegraph Corp., Lodi, N.J.

Col. Henry H. Eichel (USAF ret.): Joined Space Technology Laboratories, Redondo Beach, Calif., as a senior staff engineer.

William H. Bowman: Appointed manager of materials and production control manager at Nytronics, Inc., Berkeley Heights, N.J.

Raymond S. Fries: Appointed vice president of the Brown Instruments Div. of Minneapolis-Honeywell, Philadelphia.

Peter A. Ferrandino: Appointed regional manager of the Airborne Instruments Laboratory (AIL) Div. of Cutler Hammer, Inc., Washington, D.C.

Stanley K. Weissberg: Joined Spacelabs, Inc., Van Nuys, Calif., as vice president and technical director.

Donald R. Rasmusson: Appointed value engineering administrator at Walter Kidde & Co., Inc., Belleville, N.J.

Edward F. Janesic: Appointed general manager of Shawnee Industries, Inc. Bristol, Pa.

John L. Kent: Appointed corporate communications manager of Air Logistics Corp., Pasadena, Calif.

William J. Buffo: Appointed president and member of the board of Radiation Counter Laboratories, Inc., Skokie, Ill.

Donald E. Chelew: Named treasurer of Houston Fearless Corp., Los Angeles.

Harris J. Howard: Named manager-market planning in the Aerospace Div. of Vickers Inc. Div. of Sperry Rand Corp., Detroit.

Ira W. Kane: Appointed manager of telemetry tracking and control programs for Philco Corp.'s WDL Div., Palo Alto, Calif. Edward C. Buurma named marketing manager.

Jack I. Hamilton: Appointed vice president and executive assistant to the chairman of the board of Menasco Manufacturing Co., Burbank, Calif.

George J. Vila: Appointed manager of General Dynamics Corp.'s new Cleveland office.

Raymond Renola: Appointed general manager of the Washington, D.C., operations for Gulton Industries, Inc.

—when and where—

AUGUST

Astrodynamics Conference, sponsored by AIAA and Yale University, New Haven, Conn., Aug. 19-21.

1963 Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 20-23.

Human Factors and Computers Symposium, sponsored by Midwest Human Factors Society and AC Spark Plug Div. of General Motors, Oak Creed, Wis., plant, Aug. 23.

AIME Electronic Material Conference, Somerset Hotel, Boston, Mass., Aug. 26-28.

AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

Open Space and Peace Symposium, sponsored by the Hoover Institution on War, Revolution and Peace and by Stanford University, Stanford, Calif., Sept. 4-6.

Symposium on the Ellipsometer and Its Use in the Measurement of Surfaces and Thin Films, National Bureau of Standards, Washington, D.C., Sept. 5-6.

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

National Symposium on Space Rendezvous, Rescue and Recovery, sponsored by American Astronautical Society and Air Force Flight Test Center, Edwards Air Force Base, Calif., Sept. 10-12.

17th Annual National Convention and Aerospace Panorama, Air Force Association, Sheraton-Park and Shoreham Hotels, Washington, D.C., Sept. 11-15.

Institute of the Aerospace Sciences, Antisubmarine Warfare Meeting, San Diego, Calif., Sept. 16-18.

American University, Institute of Electronic Informations Display Systems, International Inn, Washington, D.C., Sept. 16-20.

Industrial Electronics Conference, sponsored by AIEE, IRE and ISA, Michigan State University, East Lansing, Sept. 18-19.

IEEE Annual Conference on Communications, Cedar Rapids Section, Hotel Roosevelt, Cedard Rapids, Iowa, Sept. 20-21.

National Power Conference, sponsored by ASME, AIEE and IRE, Netherland-Hilton Hotel, Cincinnati, Ohio, Sept. 22-25.

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The Moonbeam Business

VULNERABILITY of the U.S. space program to Soviet blandishment has been made all too apparent in recent days. Response to the suggestion by British astronomer Sir Bernard Lovell that the Russians have abandoned their lunar program would be ludicrous if it were not so frightening.

The British all too frequently have been gullible in their reaction to Soviet flattery and propaganda. But to find some responsible Americans susceptible to the same hogwash—or if not susceptible, willing to use it for their own ends—is disheartening.

Sir Bernard, after a Russian guided tour, took it upon himself to report to the National Aeronautics and Space Administration that the Soviet Union has dropped its manned lunar landing program because of a number of difficulties.

Mr. Khrushchev is wily enough to plant this idea just as NASA's authorization bill is making its way through the crucial stages of Congressional approval. We should be smart enough not to fall for a gambit as apparent as this one. But we are not.

One need only look at the narrow margin, a 37 to 32 vote, by which a casual amendment to slash over $300 million from the Senate Space Committee recommendations was defeated in the Senate. This same debate saw an amendment offered to make the space program the focus of new efforts to exploit so-called Soviet desires to cooperate with the West. This was proposed by Sen. Joseph Clark (D-Pa.), who also supported the proposal to slash the NASA authorization.

Fortunately, at the urging of Senate Space Committee Chairman Clinton P. Anderson (D-N.M.) the Clark amendment was withdrawn. This move did not come, however, before the Pennsylvania Democrat made it quite clear that he had been thoroughly suckered by the Soviets.

We want to suggest to Mr. Khrushchev that if he will now announce that the Soviet Union is dismantling its Air Force, sinking all its ICBM's in the ocean and abandoning Communism, Sen. Clark and his ilk can have a merry old time getting rid of Dept. of Defense, State Dept. and foreign aid budgets.

Sen. Clark quoted from Cole Porter to describe a trip to the Moon as "just one of those things." He asked, "When we do place a man on the Moon of what help will that be to us?" And he suggested that an effort be made to place "the moonbeam business" on a sensible basis.

Let us see just what sensible basis Sen. Clark had in mind when he placed Sir Bernard's letter in the Congressional Record and proposed his starry-eyed amendment. He said:

"This is an expression of a Congressional intent and willingness to match funds—dollar for dollar—with the Russians in a joint venture to reach the Moon, or in any other joint venture into outer space. . . ."

He suggested to his Senate colleagues that in trying to reach the Moon before the Russians the United States is acting like the whole thing is a college football game or perhaps a high-school cross-country race.

"I wish I knew how many billions of treasure would be taken away from domestic programs so desperately needed for our economy in order to carry out this prestige venture," the Senator lamented.

We suggest Mr. Khrushchev might want to award a couple of his medals to Sir Bernard and Sen. Clark. Short of having a vote in the Senate, nothing could have served his purpose better than the antics of this pair.

Can we still be so incredibly naive as to base our actions on what the Russians *say* they are going to do? If so, let's be sure we understand what Sir Bernard said they said. This is the Soviet space program as described by the British astronomer:

(a) A determination to perfect the rendezvous technique with an immediate aim (perhaps 1965-66) of establishing a manned orbiting space station.

(b) Continuation of unmanned exploration of the Moon, Venus and Mars leading to a soft landing of instruments on the lunar surface "in a matter of months."

(c) Rejection at least for the time being of plans for a manned lunar landing.

The phrase "at least for the time being" is Sir Bernard's and he adds that the Russians told him that the manned project "might be revived" if progress in the next few years gives hope of a solution to the problems faced.

IT IS INTERESTING to note that Sen. Clark, while deriding the lunar program, chose to ignore the statement that the Russians are heavily engaged in a project to orbit a manned space station. Surely, Sen. Clark, the Soviets should open this up to us as a joint project—on a dollar-for-dollar basis, of course?

We were quite pleased to see NASA's reply to queries about the Lovell letter:

"It represents the personal impressions of a private individual on a matter of the greatest obscurity, namely the Soviet space program."

We hope that ends all the nonsense—and that Sir Bernard and Sen. Clark now will retire to an equal obscurity.

William J. Coughlin

What does a systems engineer do at Hughes?

Responsibilities: Determine systems requirements for manned airborne electronic systems and supporting ground equipment to carry out necessary technical direction to assure system integrity. Responsibilities include logical design, signal flow designs and circuit interface requirements between portions of the system. Must be able to create control documents for technical and financial visibility.

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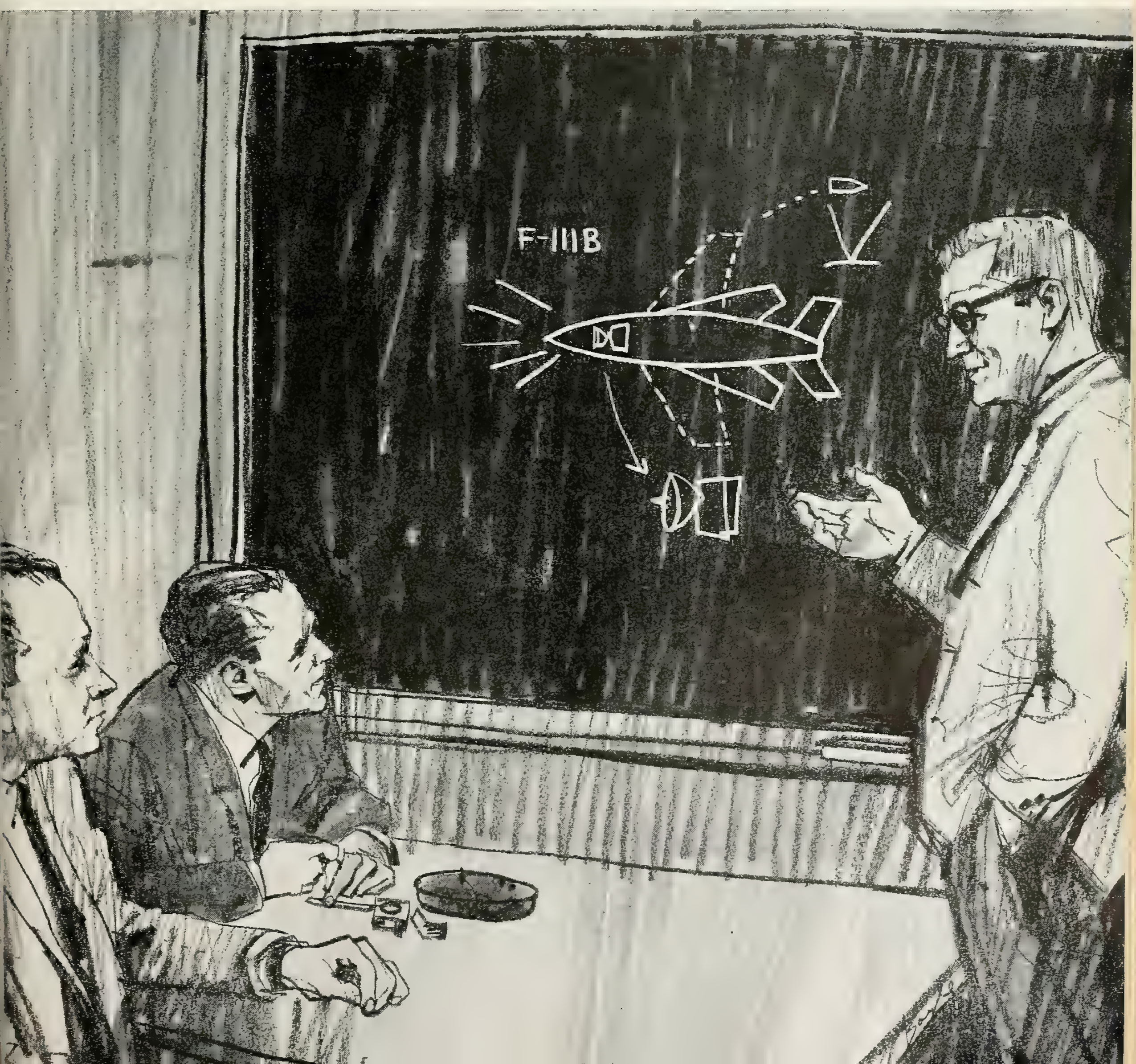

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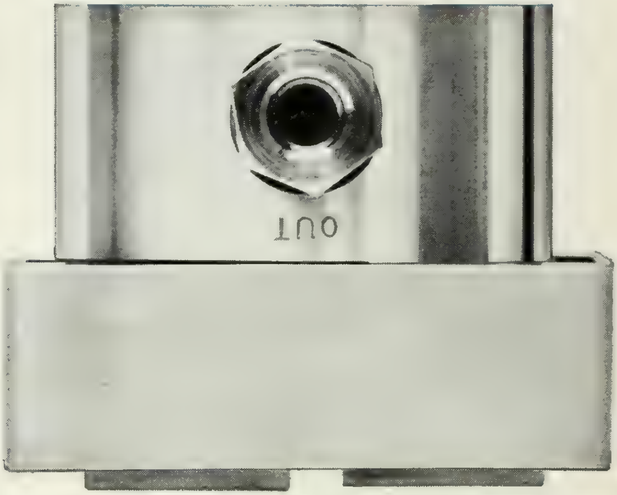

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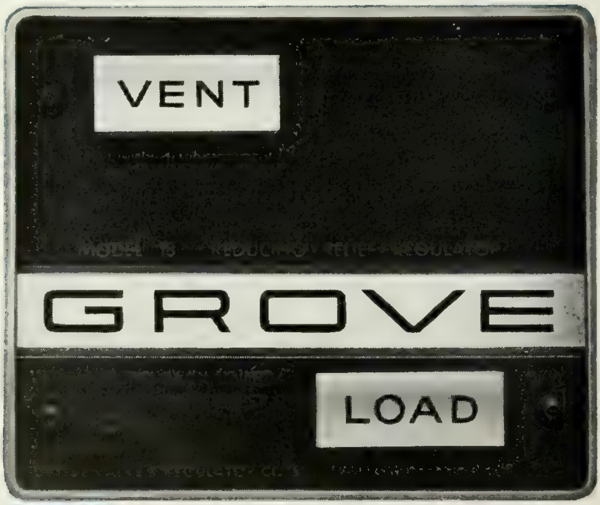

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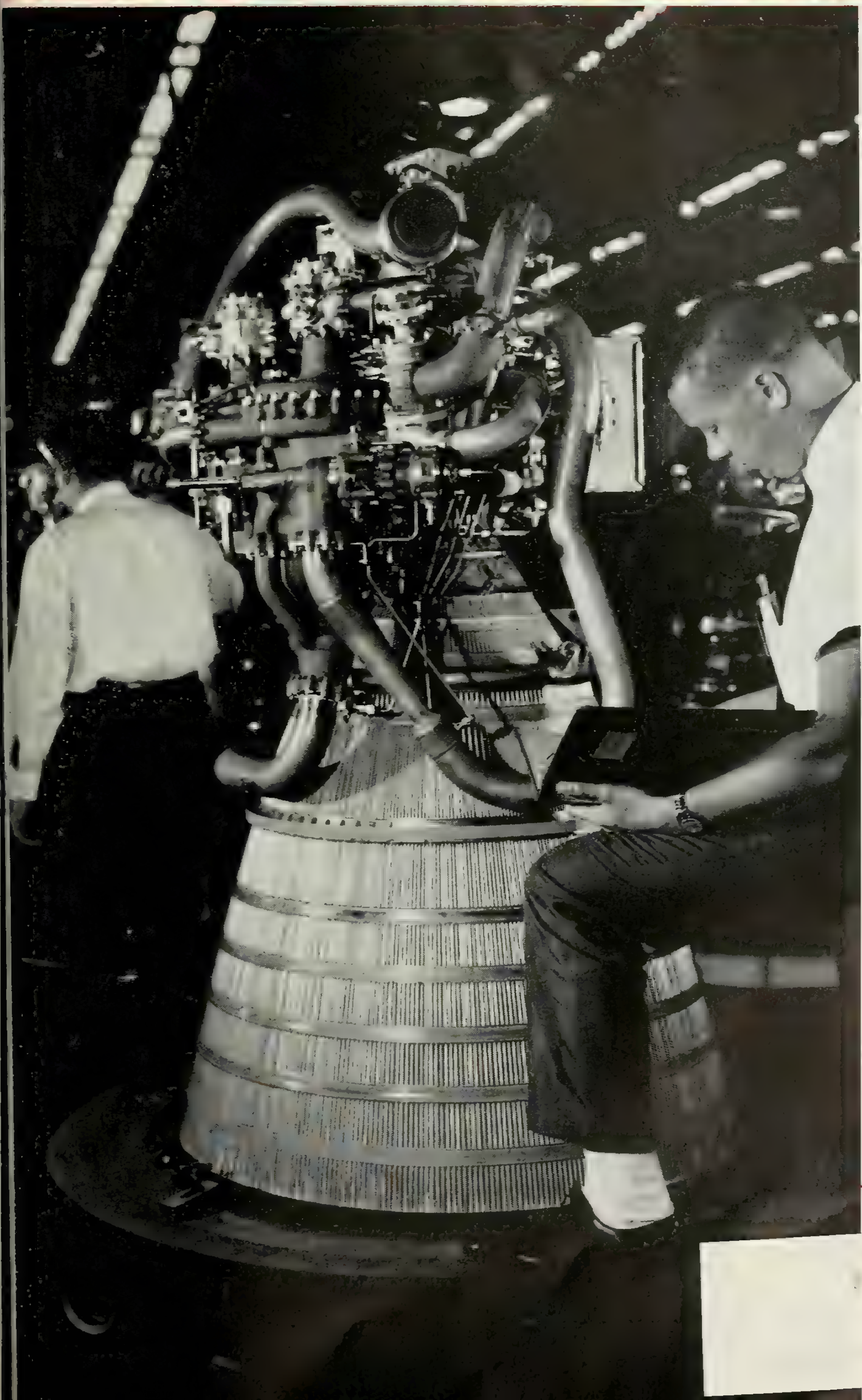
THE WEEKLY OF SPACE SYSTEMS ENGINEERING



Pentagon Decides To Continue Big Solids

Signs of Hope For MMRBM

GE Picked to Develop BIOS

Karth Urges Sales of Atlas

P&W's RL-10 Engine

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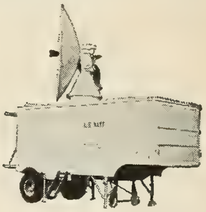

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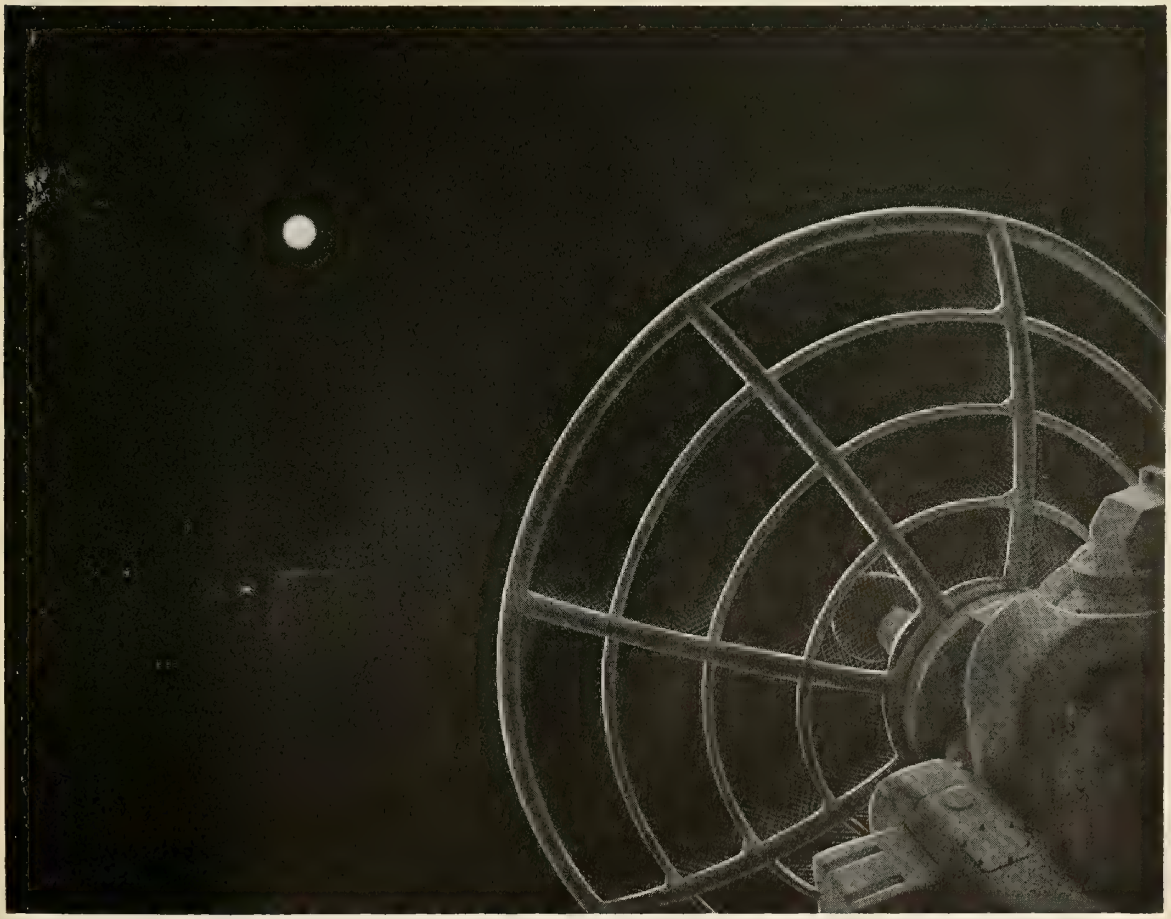

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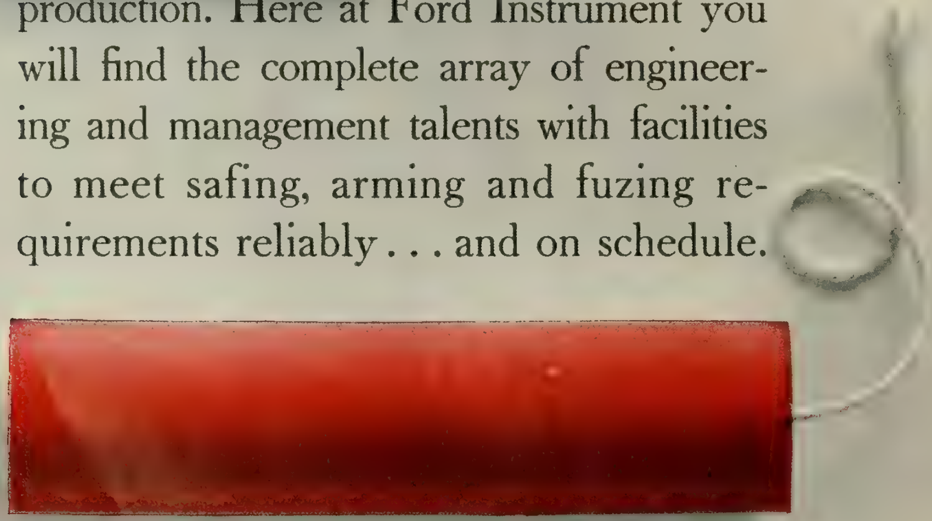

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Volume 13, Number 9 August 26, 1963

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THE COVER

Pratt & Whitney engineer checks completed RL-10 engine at firm's Florida Research and Development Center. P&W believes it can double engine's 15,000-lb. thrust level—if NASA asks it—by use of fluorine and additives in oxidizer. See p. 38.

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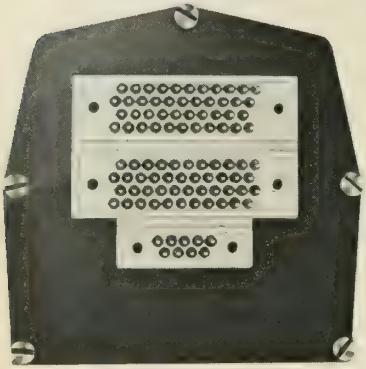

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letters

Holmes' Resignation

To the Editor:

One of your readers referred to Brainerd Holmes in a letter as a spoiled little girl who refused to play because she could not have her way.

It is my opinion that Mr. Holmes knew what ought to be done, and he could not reconcile it with what he was told to do. I imagine he must have been disheartened that we can somehow provide funds, and huge ones, to support paper empires, but we cannot find the money to do a highly technical job the right way.

I believe that he must have wondered why it is that we have the funds to pay people who actually sabotage our best scientific and technical efforts with their mediocrity, their unwillingness to study a problem, and their talents for office intrigue.

Mr. Holmes wears, in my opinion, a "white badge of courage," an injury inflicted upon him by the octopus-like, paper-pushing empire of non-technical men. I am glad he refused to compromise.

We need more men of Mr. Holmes' type, and fewer of the men who parasitically suck our taxfunds. The latter, I think, are the real "ugly Americans."

Tony Berger
Burbank, Calif.

Penny-wise Procurement

To the Editor:

The sincerity of Mr. McNamara's desires to cut procurement costs in the DOD (M/R, July 22, p. 16) is hardly questioned. However, there is a huge gap between pronouncements made from Mount Olympus and the comments heard from the troops in the field. His statements bring to mind some of the chilling after-effects of previous, and equally zealous, programs that were originated at that high level.

A prime example was the 1954 DOD crusade to eliminate "gold-plated" specifications and other frills from common hand tools. That particular exercise made much back-patting news among the DOD staff in Washington. Overlooked, however, was the ultimate impact it would have on the lowly wrench-twister, the supply parts chaser, and the other indistinguishable (but so necessary!) figures at the bottom of the chain of command.

It was solemnly decreed at that time that procurement of hand tools be pared to an absolute minimum, and that maximum competition among vendors be solicited. A monetary ceiling was established, and procurement functions were delegated to a "Single Manager." Faced with stacks of hand tool requisitions on one hand and a tight budget on the other, the Single Manager stretched his dollars out by buying cheap Japanese tools.

The results of this penny-pinching approach afforded little humor, and actually bordered on disaster. USAF mechanics, during maintenance of their multimillion-dollar first-line aircraft, were frequently dismayed to find screwdriver blades disintegrate under normal stresses, or pliers and wrenches shatter to pieces in the midst of critical adjustments. Many skinned knuckles later, the word filtered up the chain of command and the procurement instructions were hastily countermanded.

As for the Defense Secretary's emphasis on achieving savings by a concerted change over from sole-source to competitive procurement, one wonders what the proper course of action should be, under the following routine conditions:

1. When items to be procured are controlled by patent rights, copyrights, proprietary rights, and secret processes—and no other item is an acceptable substitute.
2. When work or services are required by the Government on Government-owned facilities or property in possession of a particular contractor—and it is neither practicable nor economical to have another contractor accomplish the required work or services.
3. When technical non-personal services (maintenance, overhaul or modification) of a highly technical or specialized nature, are required to support items of equipment—and the knowledge required to furnish such services is possessed only by the manufacturer or supplier of such equipment.
4. Continuation of existing projects or programs where it is neither practicable nor economical to secure competition.
5. When delivery requirements and lead time are such that only one source has the necessary technical knowledge or production capability to meet delivery—and time will not permit any other source to acquire the necessary technical knowledge or production capability.
6. When, on items covered by specification containing qualification requirements, only one source has qualified a product for inclusion in the Qualified Products List (QPL)—, and time will not permit the qualification of any other product.
7. When items are required to be procured from a particular source which has previously furnished the items because the Government does not have the capability (data, engineering know-how, etc.) to determine the suitability of a substitute item.

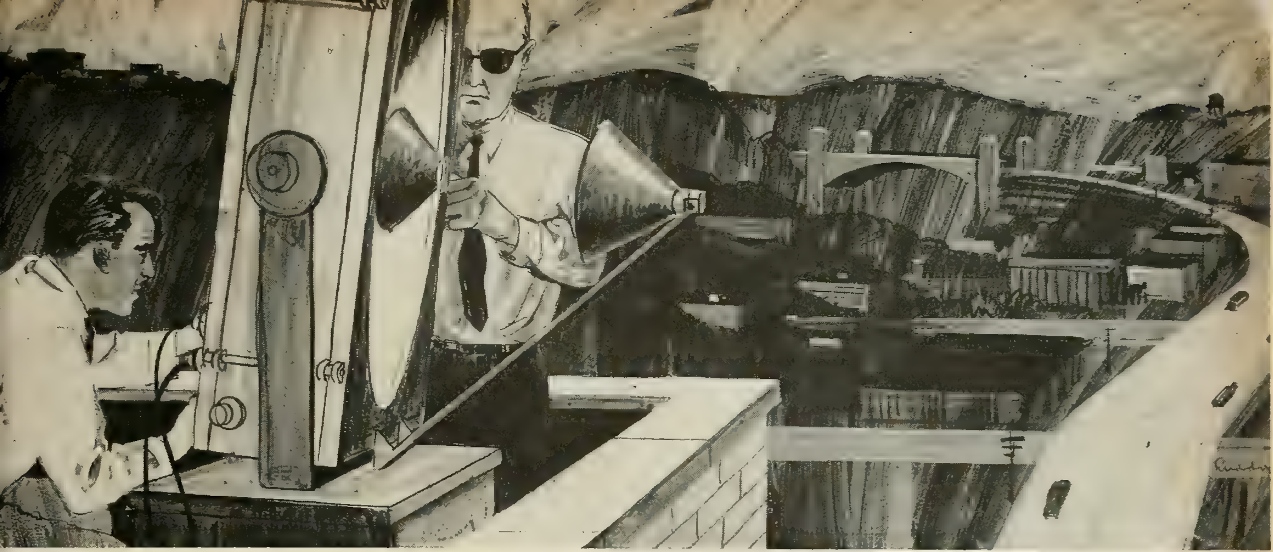
Edward P. Connors
Reseda, Calif.

Boston Center

To the Editor:

Let me thank you for your excellent Aug. 5 editorial ("Something for Boston"). We tried our utmost to bring the NASA electronics center into our area, but failed to impress the decision-makers.

Harold G. Carson
Director
Chicago Area Research & Development Council
Chicago



1933 target: vehicles on a highway

1963 target: vehicles in space

Thirty years ago, Westinghouse engineers in East Pittsburgh beamed radio waves from the plant roof and detected moving autos a block away. They didn't call it "radar"—the word hadn't been invented yet.

Radar development at Westinghouse has traveled many paths since 1933. Defense Center scientists have consistently pioneered in advancing the art—from the rooftop experiments to detecting enemy planes approaching Pearl Harbor to tracking vehicles in space.

Systems in action today include radars for airborne and space missions, search and weapon control, tactical and fixed air defense, shipborne and ground-based acquisition and tracking. Typical of current projects of the Westinghouse Defense Center are the AN/SPG-59 shipboard fire control radar for the Navy's TYPHON program and the land-based AN/FPS-27, a long-range air defense radar in the Air Force's SAGE system.

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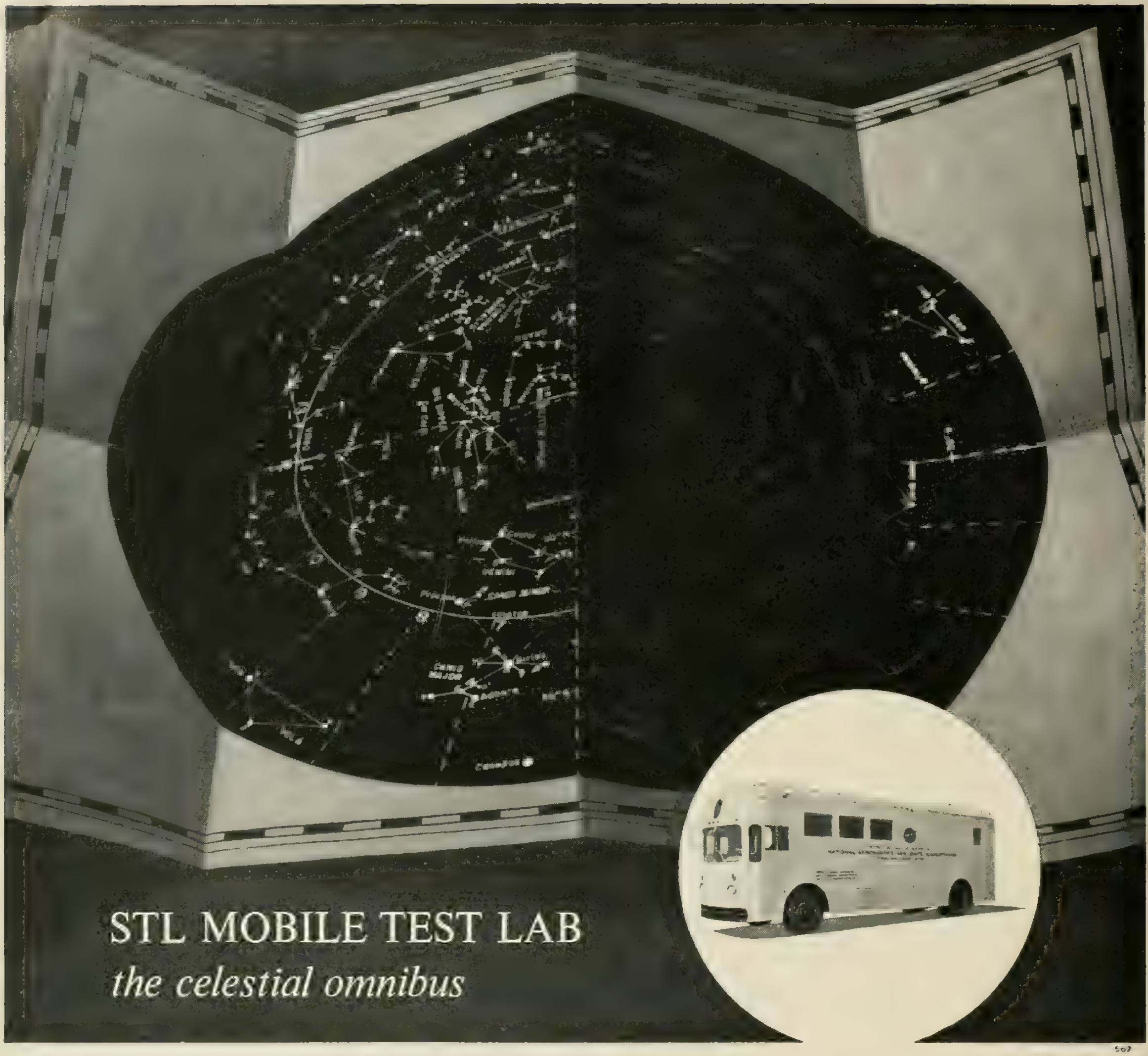

567

When a spacecraft carries as many as 50 experiments on a mission, it demands ground support equipment with broad capabilities to chart its course. Mobile Test Labs, designed and built by TRW's Space Technology Laboratories can simulate, measure, record and evaluate 64,000 bits of telemetry data each second. Operating under manual, semi-automatic, or completely automatic control these vehicles utilize telemetry data for on-line testing and monitoring of spacecraft electronic systems during integration, assembly and pre-launch test. STL scientists and engineers are using this equipment to test NASA's Orbiting Geophysical Observatory (OGO), Air Force-ARPA 823 spacecraft, and other classified vehicles.

Space programs such as this, and continued Systems Management for the Air Force's Atlas, Titan and Minuteman programs create immediate openings in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For information on positions in Southern California or Cape Canaveral, write Dr. R. C. Potter, One Space Park, Redondo Beach, California, Dept. B-8, or P.O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Air Force Gemini Funding Expected

Air Force is expected to put about $20 million into the *Gemini* program during Fiscal 1964 for limited, piggyback research. This could be increased, however. Pentagon officials have asked Congress to make it possible to use *Dyna-Soar* funds for *Gemini* in the event *Dyna-Soar* is cancelled.

Consideration of NASA Budget Moves Forward

NASA's FY 1964 authorization is grinding slowly toward final action. The House last week defeated a move to instruct conferees to accept only the House bill, which cuts more than $508 million from the $5.7 billion request. The Senate version cuts $211 million. First House-Senate meeting is scheduled this week.

Dyna-Soar's Fate Is Still Uncertain

Despite remarks last week by Dr. Eugene G. Fubini, assistant secretary of defense, that "we are proceeding with the *Dyna-Soar* and *Gemini* programs as insurance," Pentagon observers believe DOD still is considering *X-20* cancellation. Review of the program is on Secretary McNamara's desk.

New Bios Satellite To Use TAT Booster

The new General Electric *Bios* satellite will be the first NASA project to use the *Thrust-Augmented Thor (TAT)* launch vehicle, a standard *Thor* with solid boosters which is in Air Force use. NASA still has not announced approval of the *TAT* program and no contracts have been signed. Both actions are expected in the near future, however.

No NASA Interest in Up-Rated RL-10

NASA apparently has no plans which would require use of new medium-size engines in upper stages. Pratt & Whitney officials recently discussed with the space agency an uprating of thrust of the RL-10 engine from 15,000 to 30,000 lbs. NASA's position: not interested in an expensive program to develop, in effect, a new engine for which there is no requirement. The agency is now negotiating a $30-million follow-on contract with P&W which will cover development of the present RL-10 through flight qualification.

NASA Seeks Communication System

Manned Spacecraft Center at Houston has asked for proposals by Sept. 6 on an optical communications system to provide a one-way link between spacecraft and ground stations. Ground station is to be located at the White Sands Missile Range, N.M. System is expected to operate from spacecraft in 100-to-300-mi. orbits.

INDUSTRY

Bios Award No Help to GE Unemployment

Award of the $19-million biosatellite contract is not expected to significantly alleviate employment layoffs at General Electric's Missile and Space Division. These are expected to continue for several more months. Personnel for the *Bios* project will be shifted from other programs now phasing out, notably the Mark VI re-entry program.

DOD Adopts New Financial Rules

Dept. of Defense has established new criteria for recovery of money from contractors who profit from sales of civilian versions of military equipment. These include: 1) ratio of military sales to commercial sales, 2) government's investment in development and tooling, 3) percent of commonality of commercial and military versions, and 4) learning-curve benefits from military production. Determination will be made when commercial orders are received.

FBI Probes Bribe Case

FBI last week arrested a vice president of Loral Electronics, New York City, charging him with a bribe attempt at Wright-Patterson AFB, Dayton, Ohio, involving a $9.5-million contract. Agents said they picked up the Loral official, Morton Siegel, after watching him give an undisclosed sum to Charles Lopez, the Electronic Warfare Branch chief at the base. An FBI spokesman said Lopez tipped off the FBI several weeks ago that Siegel was making overtures in connection with the classified contract.

INTERNATIONAL

Germany Buys Arcas Sounding Rockets

Germany has ordered 140 Atlantic Research *Arcas* sounding rockets for atmospheric research projects during the International Quiet Sun Year (IQSY). Contract with the Virginia firm, placed through Bureau of Naval Weapons, is worth $246,746. Payloads will be of two types, *Arcasonde* and *Arcas Robin,* one deploying a parachute, the other a balloon.

Soviets Say Will Attempt Rendezvous Soon

Moscow radio has announced that the Soviet Union will attempt orbital rendezvous of two space capsules "in the very near future." The Russian announcement said earlier tandem *Vostok* flights were part of the rendezvous program but that no attempt to link them during flight was planned.

Swedish Rocket Program Scores Success

Sweden's Project "Kronogard 63," a joint NASA-University of Stockholm space research project, reports success with three out of three *Nike-Cajun* probes fired this year from the Vidsel missile range. A fourth launch is scheduled.

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The Missile/Space Week

Officials Differ on Titan II

Manned Spacecraft Center officials are in sharp disagreement over the effect of *Titan II* engine problems on the two-man *Gemini* space program.

Chris Kraft, flight operations director for Project Mercury, told a press conference at Blacksburg, Va., that the first stage engine is generating an oscillation that could cause "the pilots to have their eyeballs shook out." The second stage, he said, is producing only about 90% of desired thrust and that this could result in a 700-lb. reduction in the *Gemini* spacecraft weight.

Gemini project director Charles Mathews sharply disputes Kraft's claims. He said that there have been some *Titan II* flights in which the second stage booster has exhibited low thrust, but that this is not basic to the booster. He said the source of the trouble is known and appropriate fixes are already at work.

"There have been a large number of *Titan* flights in which this problem was not evident and which demonstrated an adequate performance margin for the *Gemini* mission without any modification to the present spacecraft," Mathews said.

With respect to the oscillation, he continued, "modifications have already been made which significantly reduce it, and other modifications are under way which should further decrease the level of oscillation."

Kraft, who probably will direct *Gemini* flight operations and who is known as being outspoken, said, however, that the oscillations are being reduced by increasing pressurization in the fuel tanks.

He declared that he is not in favor of the method because "you can't count on the fact that the pressurization system won't fail during launch."

"We want it permanently fixed," he said.

NAA Apollo Award Sets Record

NASA and North American Aviation Inc.'s Space Information Systems Div. have signed the space agency's largest contract, $934.4 million for development of the *Apollo* spacecraft's command and service module.

The contract will cover work through mid-1965. It requires the company to provide 11 flight-configuration spacecraft, 15 boilerplate spacecraft (as engineering test models) and 10 mockups. Development and testing will involve launch of seven of the boilerplate models and four of the spacecraft from White Sands Missile Range, N.M., and Cape Canaveral, Fla. The other boilerplates and spacecraft will be subjected to various ground, airdrop and parachute-descent tests. The contract will also require the company to provide 10 additional spacecraft at various stages of their production.

Under the pact, North American is to include two mission simulator trainers—one to be located at Cape Canaveral and the other at NASA's Manned Spacecraft Center in Houston—and various ground support equipment.

Navy Sets A3X Sub Firing

The *Polaris A3X* will undergo its first firing test from a submarine in October or November, according to the Navy. The launch off Cape Canaveral probably will be from the USS Andrew Jackson, commissioned in July. Meanwhile, the Navy said it is highly satisfied with testing progress on the *A3X*, planned for 2,500-n.-mile range. Thirteen of 23 test shots have been successful.

Centaur Test-Fired

The *Centaur* vehicle stage was fired Aug. 17 for the first time with both RL-10 engines equipped with flight-type propellant supply systems, including tanks, pumps and plumbing.

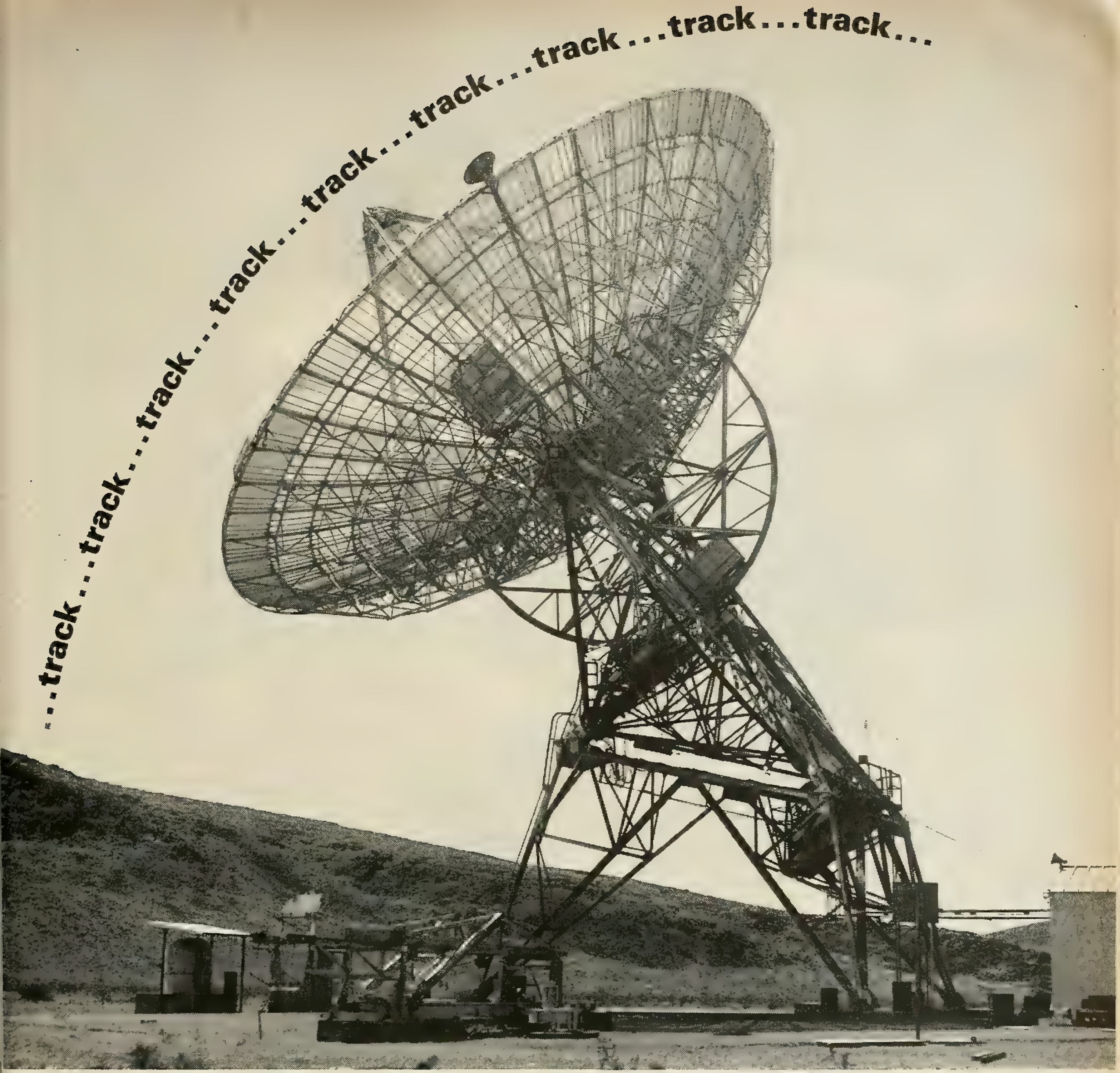
The test, at General Dynamics/Astronautics, San Diego, Calif., ran for the planned 30 seconds, in a steam-diffusion chamber to simulate space vacuum.

The *Centaur* will be given a test run of more than 300 seconds, at a location other than San Diego, before shipment to Cape Canaveral.

DOD Buys Space Insurance

The Department of Defense views *Dyna-Soar* and *Gemini* as "insurance" against the uncertainties of future military space missions, according to Dr. Eugene G. Fubini, assistant to DOD's Director Defense and Engineering.

Speaking to the National Rocket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JPL tracking antenna does it with high accuracy hydraulic power for drive and control

Tracking objects thousands of miles deep in outer space calls for fast, smooth action and extraordinarily accurate control. The new 85-foot diameter receiving antenna pictured here is operated for NASA by the California Institute of Technology Jet Propulsion Laboratory.

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Club in Washington, Fubini expressed hope that DOD-NASA cooperation on *Gemini* and *Dyna-Soar* will provide some answers that will help clarify man's possible role in military space.

Fubini reiterated the DOD statement that there are no plans to make *Dyna-Soar* an operational military system. He said, in fact, that DOD is a long way from a decision on whether man has a military mission in space. The fact that DOD is proceeding with *Dyna-Soar* at all, however, is taken by space glider proponents as encouragement that the *Dyna-Soar* program may survive, at least in some form.

Shots of the Week

The Army celebrated the tenth anniversary of the first successful *Redstone* launch by firing the medium range missile from the White Sands Missile Test Range, N. M., Aug. 19. The latest firing was tenth in a current series of successful tests at White Sands by the *Redstone* Field Artillery units.

Other shots of the week:

- The Navy launched a *Polaris A3X* the night of Aug. 19 from a Cape Canaveral land pad. In addition to usual test objectives, the vehicle carried equipment to photograph exhaust flame patterns during flight. The test was termed "very successful."
- The Army's *Pershing* missile, in its first away-from-Canaveral launch, made a successful flight over the White Sands Missile Range, N. M., Aug. 20.
- The Air Force successfully fired a *Titan I* ICBM Aug. 15 from Vandenberg AFB, Calif. Launch was conducted by the 395th Strategic Missile Squadron, SAC.
- The Air Force fired a *Titan II* ICBM Aug. 21 from Cape Canaveral bearing a scientific passenger pod containing instruments to study radiation in the missile's exhaust plume. The vehicle also carried a malfunction detection system similar to the one to be incorporated in the *Titan II Gemini* booster.

Syncom II on Station

NASA reports that *Syncom II* is in the desired figure-eight synchronous orbit over Brazil and the South Atlantic.

The space agency estimates that the satellite has enough nitrogen and hydrogen peroxide gas aboard to maintain its position at 55 degrees west longitude for about two years.

NASA Birthday Banquet

FIFTH ANNIVERSARY of the National Aeronautics and Space Administration will be observed in Washington, D.C., with a banquet on Oct. 5 sponsored by Aerospace Industries Assn., American Institute of Aeronautics and Astronautics, and the Aviation/Space Writers Assn.

The black-tie dinner will be held in the ballroom of the Sheraton-Park Hotel, with a speaker of the highest national prominence, it was announced this week.

Tables and individual tickets at $20 per person are available through AIA's Washington office, 1725 De Sales St., Washington 6, D.C.

The banquet also will mark the formal premiere of a new NASA film covering the nation's space progress during the past five years.

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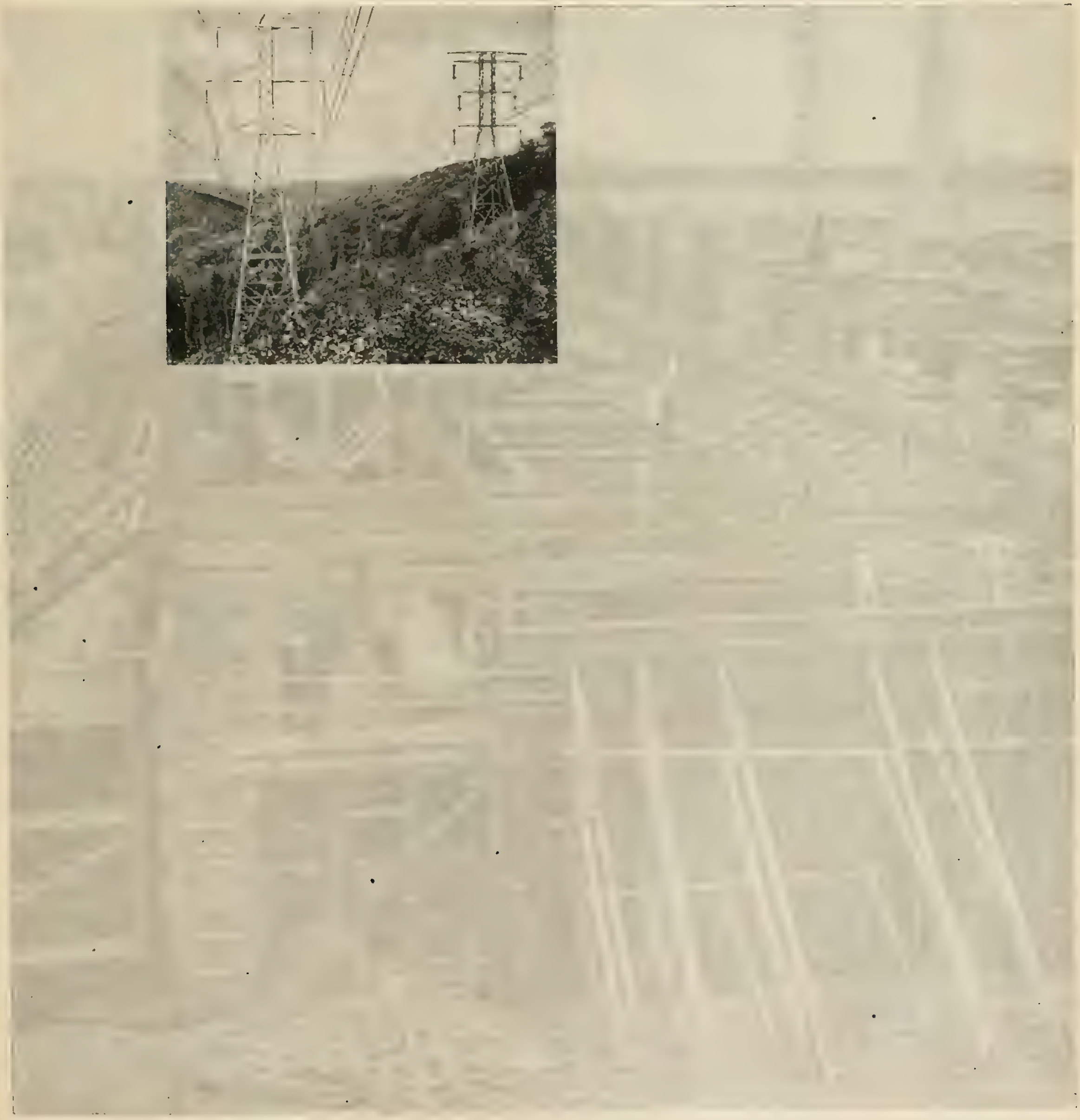

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DOD Proceeding with Big Solids

Department accedes to wishes of NASA and powerful Congressmen, reverses plan to stop 260-in. work

by Hal Taylor

PRESSURE from Congress and NASA has forced Dept. of Defense to drop plans to kill the big 260-in. solid motor development program.

Funding for big solid, in Fiscal '64, however, will still be $12 million below the level set by Secretary of Defense Robert S. McNamara and NASA Administrator James E. Webb in their November, 1962, agreement which established the joint NASA-DOD program.

Continuation of the program was revealed by Deputy Secretary of Defense Roswell L. Gilpatric in a statement before the Senate Defense Appropriations subcommittee.

"We have reversed a tentative decision to cut back the program and will now go ahead," Gilpatric said.

He added that DOD was doing this despite the fact that "we don't see any requirement for it."

- **Three pressurers**—Gilpatric told Sen. Richard B. Russell (D-Ga.), in whose state Thiokol Chemical Corp. plans to do its big solids work, that DOD reversed its position following a letter from NASA Administrator James E. Webb to Russell which alleged that the reduction in the solid program would delay the U.S. booster program by one year.

Russell is chairman of the Defense Appropriations Subcommittee, before which DOD officials are pleading for restoration of $437 million cut by the House of Representatives from the department's Fiscal '64 appropriation bill. Thiokol is the major contractor in the big solid program.

What Gilpatric did not comment on was the pressure brought to bear on a reluctant DOD by other powerful Congressmen, such as Sen. George Smathers (D-Fla.) and Rep. George Miller (D-Calif.), chairman of the House Space Committee.

Aerojet-General Corp., another program contractor, is building a plant in Florida. Lockheed Propulsion Corp. is doing its solid work in California.

Informed sources report that all three legislators privately informed DOD that the solid propulsion program is needed. To buttress his argument, Russell asked Administrator Webb for a copy of the letter which the space agency sent to DOD in opposition to the proposed reduction.

Miller hinted publicly that if DOD carried out the planned cutback in the program, it might be a good idea to switch its direction to the space agency.

In disclosing DOD's decision to go ahead with the program, Gilpatric told the subcommittee that when the House cut $2 billion from the Defense Department's Fiscal '64 budget, the department made a tentative decision to delay the program for at least a year. This would have cut Fiscal '64 funding from $46 million to only $16 million. Work on a 156-in. motor was to continue, but the 260-in. motor development would have been halted.

After seeing the Webb letter, Gilpatric said, DOD reversed itself and decided to continue the 260-in. work in Fiscal '64 and '65.

As a result, Gilpatric told the subcommittee, DOD will increase Fiscal '64 funding to $34 million, with the remaining $12 million to be added in Fiscal 1965.

- **NASA happy**—The DOD decision should add a degree of stability to the on again-off again status which has plagued the project—once designed as a backup to the NASA manned lunar landing booster effort (M/R, July 16, p. 16).

NASA officials said they are satisfied with the decision. They added that although funding will be stretched out, DOD apparently expects to stick to the same development schedule.

Funding plans now call for budget requests of $54 million in FY '65 and $47 million in FY '66.

The schedule calls for the first firing of a 156-in. nozzle in November, 1963, two more firings of 156-in. motors in May or June, 1964, two firings of a half-length 260-in. motor in October, 1964, and two more of the latter in May, 1965. Firing of the first full-length 260-in. motor would come in May, 1966. ■

GE Selected to Build Bios Satellites

NASA HAS SELECTED General Electric Corp.'s Missile and Space Div. to develop a recoverable *Bios* satellite system with one-month orbital capability.

Value of the contract—under which GE will build six flight spacecraft, plus ground-test models—is estimated at $19 million.

The 1,000-lb. satellite will be launched by a *Thrust-Augmented-Thor* (*TAT*) into a 200-mi. circular orbit from Cape Canaveral beginning in 1965.

The space agency said final determination of experiments which will be conducted during the flights has not been made.

About 150 proposed experiments have been received and the final decision will be made by NASA's Office of Space Sciences and its Bio-Science Advisory committee.

Experiments under consideration, NASA said, include:

—Orbital flight to study effects of weightlessness on biological processes at the cellular level, using tissue samples.

—Three-to-five-day orbital flights to determine the effect on plants and animal specimens of weightlessness and radiation exposure.

—14- to 30-day orbital flights of small primates to study the effects of long space flights on the cardiovascular and central nervous systems.

N. J. Dragann has been named project manager by GE. Previously, he served as program manager on the firm's NERV and *BIOS I* programs. He also was associated with the *Discoverer* program.

In Congressional testimony . . .

MMRBM Shows Some Signs of Life

JCS want $100-million cut restored, Gilpatric says timing is issue; highlights of budget testimony

by Heather M. David

PROSPECTS that the *Mobile Medium Range Ballistic Missile (MMRBM)* may yet be revived as a weapon system appeared last week when the Joint Chiefs of Staff entered a protest against any delay in the program as a result of Congressional budget-cutting.

At the same time, Deputy Secretary of Defense Roswell L. Gilpatric told the Senate Defense Appropriations Subcommittee that the only point about *MMRBM* on which Defense Secretary Robert S. McNamara and the Joint Chiefs of Staff now differ is timing.

Earlier, it seemed that the weapon was dead. Many observers felt that McNamara's decision not to ask restoration of the $100 million the House cut from the program was a portent of its cancellation. Then, on Aug. 9, DOD issued a terse statement that the weapon system itself had been cancelled, although work on its guidance, command and control aspects would continue.

Gilpatric testified last week that the Pentagon presently plans to spend about $60 million this year on "the pacing elements of this system," such as guidance and command and control components. However, JCS chairman Gen. Maxwell D. Taylor testified that the Chiefs oppose the Secretary's decision not to ask for return of the $100 million because they feel lack of the funds will slow the program down by 12 to 18 months.

• **Contractor reaction**—Contractors General Precision Inc. (STellar INertial Guidance System—STINGS) and Martin Marietta Co. (command and control) have been caught in the switch by McNamara's apparent sudden loss of interest in the program this year, and are said to be working at a reduced level in fear that the program will be completely cancelled. The House-approved appropriation leaves only $43 million for *MMRBM* in the Fiscal 1964 budget. However, insiders say it now appears that DOD is planning to shift an extra $17 million from DDRE funds.

Martin Marietta seems to be on firm ground with its contract, since it is not necessarily tied to *MMRBM* and is considered a necessary military requirement, but GPI is somewhat less secure.

However, both military and DOD civilian chiefs now are making strong show of support for *MMRBM*—whether it be pushed now or a year from now. When asked why the missile was needed when the U.S. has *Polaris* and a variety of medium-range missiles, Taylor said "if *MMRBM* pans out, it will be the most efficient and most economical weapon against a variety of worldwide targets." He added that it eventually will be deployed in the Far East as well as in NATO countries, which are counting heavily upon the program.

• **Other adjustments**—Gilpatric told the Defense Appropriations Subcommittee, chaired by Sen. Richard B. Russell (D.-Ga.) that DOD has decided to try to absorb about 45% of the cuts made by the House in the appropriations bill, and to request restoration of $437 million, permission to transfer $247 million from Defense stock and industrial funds to military personnel account, and a "rain-check" on $140 million cut from personnel funds if it is needed.

Gilpatric also said that since the original request workload requirements of $100 million more have been identified. "Therefore, failure to restore the $437 million . . . and other two related requests would, in Mr. McNamara's and my considered judgment, make it impossible to carry out the required Defense program."

Director of Defense Research and Engineering Dr. Harold Brown told the committee that a number of programs will have to be deferred under the level of funding presently contemplated. Among these, he said, is a space-power supply program, which was to be funded jointly with Atomic Energy Commission. Although Dr. Brown did not specify which project this was, it is believed to be SNAP 2, for which flight tests are scheduled to begin in 1966. SNAP 10A funds are also in the FY 1964 budget, but testing begins in 1964-65.

One program which a few weeks ago looked earmarked for deferment was big solid-motor development. However, Gilpatric said that in view of NASA's expressed need, DOD is now asking for reinstatement of $18 million for 1964, plus that $16 million which the House cuts left in the program. (See p. 16.)

• **Communications satellies**—One of the largest single amounts the Department wants restored involves communications satellite program. The House cut $59.6 million on the grounds that $59.6 million in FY 1963 funds which had originally been appropriated for *Advent* were now available. However, DOD said this actually was a program reduction, since the money already had been earmarked for the communications satellite program. Thus, Gilpatric said, DOD is asking restoration of $44.6 million of this money.

Brown said the medium-altitude satellite still will be the mainstay of defense communications, but may be supplemented later with synchronous satellites.

• **Dyna-Soar—etc.**—DOD has not progressed any further toward deciding the fate of the Air Force *Dyna-Soar*, although Chief of Staff Gen. Curtis LeMay rose to make an adamant statement regarding its need. McNamara is asking only that the wording on the $125 million the House put in a fund for use on *"Dyna-Soar* or Mach 3 vehicles" be extended to include "space vehicles," as well.

Brown said this was in the contingency that the Air Force wanted to put more money in *Gemini* than is presently envisioned. He also admitted, however, that even an expanded *Gemini* would not require the total $125 million, and that DOD wanted the flexibility to initiate another manned space program if it deemed one necessary.

Gilpatric said that besides this, DOD needs the funds deleted by the House from the space programs, which came under a general 3% cut in RDT&E. He said DOD will try to absorb about $64.1 million of the general reduction, which totaled $114.6 million, but requests the balance, $50.5 million. In RDT&E, he said, is a classified project which cannot be cut in any way. "All I can tell the committee in open session is that this project is of such importance that no cut whatsoever should be made in funds for its support." ■

JFK leads rebuttal . . .

Teller Broadens Attack On Test Ban Agreement

by David C. Breasted

THE SOVIET UNION could steal a crucial march on the United States in anti-ballistic missile (ABM) development by staging a quick series of atmospheric nuclear tests in disregard of the test ban treaty, Dr. Edward Teller declared last week.

This was one of a string of vigorous warnings delivered by the Hungarian-born physicist in testimony before a joint meeting of three Senate committees holding hearings on the treaty recently initialled in Moscow.

Teller's criticism of what he called seriously inadequate testing capabilities under the treaty—and in the past—brought quick and powerful Administration rebuttal, led by President Kennedy at his Aug. 20 news conference.

Meanwhile, previously muted opposition to the treaty within the Air Force came into the open.

Teller, a member of the Air Force Scientific Advisory Board, contended that the Soviets already enjoy an ABM lead and could widen it dangerously through a fast treaty-breaking series.

"If they should find the results unsatisfactory, they will have lost the treaty," he said. "If they find them satisfactory, they will have won the world." He repeated his earlier warnings that the U.S. cannot count on an ABM system it cannot test with atmospheric explosions. He also charged that the Administration broke off the 1962 U.S. atmospheric test series for political reasons.

• **Kennedy counters**—On these two scores, the President told his news conference that:

—Secretary of Defense Robert S. McNamara's statement on the ABM question "is the clearest and most specific answer that you could possibly get on what effect the atmospheric test ban will have on the development of this weapon."

(McNamara had testified earlier that the U.S. could develop an ABM system by theoretical analysis of data available on the blackout problem, and by testing warheads underground.)

—As for the 1962 series, the President said, "I think we did the major tests. . . . But it would be very difficult, I think, to satisfy Dr. Teller in this regard."

The President reassured the nation and the defense community that the Administration will pursue four safeguards requested by the Joint Chiefs. These included underground testing, development of improved devices to detect nuclear explosions, continued vitality in the laboratory, and preparation of an atmospheric testing program in case the Soviets abrogate the treaty.

President Kennedy cited current test preparations at Johnston Island in the Pacific for the "unhappy eventuality" of Soviet violation.

Teller said he feels that on the question of an ABM system, McNamara "underestimates the importance of actual operational tests." He said he agreed with McNamara that the U.S. can proceed with ABM development under the treaty, but "I am not in agreement that we can complete this development."

He urged that the Senate ask official witnesses in executive session what kinds of ABM tests have been proposed, how many, and at what cost.

He also told the Senators that nothing he has seen proposed could be an adequate substitute for atmospheric explosion in determining the vulnerability of hardened missile sites to explosive overpressure.

McNamara in his Senate statement termed U.S. and Soviet experience in ABM experiments "comparable." But Teller cautioned that "the kind of information by which you make such a judgment is incredibly hard to come by."

He said that "by expanding and perfecting the *Polaris* missile system, we could ameliorate the situation." This would mean, however, an effort "to make up in money what we cannot acquire in knowledge."

Teller admitted that his present stand contradicts his statements of past years, particularly 1960, but he said the Soviets had not then demonstrated the technological capabilities they have since shown. Teller admitted that "I have simply changed my mind." All in all, he said, the present treaty amounts to "a step away from knowledge, a step away from strength, and a step away from peace."

Teller's lonely dissent received support from Dr. John S. Foster, Jr., director of the Lawrence Radiation Laboratory at Livermore, Calif., who said that from "purely technical-military considerations, the proposed treaty appears to me disadvantageous." He said the pact "would not only limit our knowledge of the actual state of Soviet military development, but would also restrict our knowledge of what may even be technically possible."

• **Brown optimistic**—But the testimony of both men contended with the official weight of statements from Dr. Harold Brown, DOD director of research and engineering, who said that the major problems of ABM development "have little or nothing to do with further nuclear testing."

He said "I do not believe we are behind, and I strongly believe that we are not very far behind" in ABM development.

Brown said he does not believe the Soviet 1961-62 tests were nuclear effects tests on ABM systems. He said that "the worst that can happen" if the Soviets cheated on the treaty would be a small, temporary military advantage.

The research head said also that he does not believe the Soviets have intercepted an incoming warhead. Nor have they apparently installed an operational ABM system, Brown said.

He conceded that under the treaty conditions "we will have to compensate for slightly more uncertainty" in ABM design. The treaty would not inhibit the U.S. and allow the Soviets to gather data unhindered, he said.

The Soviets, he said, would have "no very good reason" to go to the colossal expense, with dubious prospects, of going into deep space to test weapons. Of Teller's ABM position, Brown said "He thinks I'm wrong; I think he's wrong."

• **AF uneasy**—The leading voice of cautious Air Force skepticism, Chief of Staff Curtis E. LeMay, was notably unenthusiastic about the treaty. He said he could not definitely state that the U.S. would not be hurt by the treaty. He said "we can develop an anti-missile missile with a reasonable amount of confidence," but that "we won't know for sure unless it can be exploded."

Gen. Bernard L. Schriever, Air Force Systems Command chief, told the Senate Preparedness Subcommittee in closed session that he could do his job better without the treaty. He said the pact would impose limitations upon him, and involved certain disadvantages and risks, according to Subcommittee chairman Sen. John Stennis (D.-Miss.)

Nor did the treaty sit well from a military standpoint with Gen. Thomas S. Power, SAC commander, who said it was against the best interests of the nation. ■

ntastic market . . .'

Rep. Karth Urges U.S. Sell Boosters

House expert says sales would make jobs, ease gold problem with no risk to U.S. security

KARTH: *"Booster sales may be just what we need . . ."*

THE U.S. SPACE industry has a "fantastic future mar- " for boosters and advanced systems in the developing ropean space programs.

Exploiting this market will bring financial profit to U.S. mpanies, help stem the worrisome flow of gold out of the untry, and lessen the persistent unemployment problem.

In giving these opinions to MISSILES AND ROCKETS, Rep. seph E. Karth (D-Minn.) draws from his four years' ex- rience as a charter member of the House Space Committee d his current chairmanship of its Subcommittee on Space iences and Advanced Research & Technology. He also lls how the U.S. can sell *Atlas*, *Centaur* and *Saturn* to reign countries with no security problem.

This interview with Karth was conducted by M/R Senior ditor William Beller.

Q. *Mr. Karth, you have expressed the belief that the S. should do more to tie in with the emerging space pro- rams in Europe. Why is that?*

A. I feel this is a good area for us to explore because we re suffering from persistent unemployment, excessive out- low of gold and an imbalance-of-payments problem. I am nindful that the President on quite a number of occasions as expressed deep concern about these matters.

In many areas, boosters for example, where we have gone through the extremely expensive research and development phases—these are the areas we should now exploit with the friendly foreign countries. We should see if we can sell some of this great technological development. It may prevent them from developing their own and therefore lead to a fantastic future market.

Q. *So far only Scouts and Thors have been available to European countries. Could they get the Atlas?*

A. I would say so, under these conditions:

One, that they pay for the vehicle—I don't think we should give it away.

Two, we would need to launch it for them. They don't have the launching pads and probably can't get into the tremendously expensive launching pad, gantry, electronic-type setup that goes with the launching of a major booster system for some time. But eventually they would, because they are serious about their own space programs. Third, whatever secrecies surround the launch vehicle and/or other devices, all of this would be handled by U.S. personnel.

Q. *Why should foreign countries pay for boosters if NASA is willing to provide them free for programs of mutual scientific benefit?*

A. That's the catch. In my opinion, other nations are not as interested in advancing scientific exploration as they are in embarking on programs to advance their own economic position. And in this instance I say it's fine for us to cooperate by selling to them a booster or whatever other paraphernalia they need.

As these countries become more involved in space programs, it may be they will be desirous of buying *Saturns* or *Centaurs*. We don't necessarily need to stop at *Atlas*. I think the whole high-thrust field of boosters is a tremendous market with great potential.

Q. *How could such sales be handled, government-to-government?*

A. My first opinion is we should do this through an agency of the U.S. government, probably through the Defense Department or NASA. Whatever profit might be involved does not go to NASA, does not go to DOD—it goes to private industry, to those who make the *Atlas* or the *Saturn* or *Centaur*. This money gets back into the economy. It provides jobs. It stimulates the U.S.'s gross national product, causing our overall economy to grow and expand.

So I don't really think it makes too much difference whether or not sales of our space capabilities to foreign interests are made through an agency of our government. However as a matter of convenience or protocol—or a requirement, from an international standpoint—this may well be the best if not the only procedure.

It would merely be an agency of the U.S. government making available to the foreign country under prescribed conditions, a booster or a space system or whatever it may be. Then these countries would contract for this work in terms of dollars and cents with the U.S. manufacturer, whoever that might be, through the U.S. Government.

Q. *Could a foreign country—or U.S. industry, for that matter—now proceed to design a project about a large U.S. booster and feel that there is a high probability that under proper security measures it could get such a booster? Would there be anything against U.S. policy?*

A. Nothing that I know of, if the proper security precautions are taken. The missile or the launch vehicle would not leave this country. It isn't a matter of shipping it to a foreign country where they could tear it apart and see how it is made, and gain whatever information might be held secret in the U.S.

No, I don't see any laws or rules or regulations that would be violated if we merely made our space capabilities available to foreign countries, with all the proper secrecy precautions taken, for the purpose of launching one or a dozen or five dozen of their space systems.

Q. *This means, then, Mr. Karth, that General Dynamics —for instance—could try to sell its launch vehicles directly if it got the blessings of the requisite agency in the U.S.?*

A. If it involved launch vehicles around which there are no matters of security, yes sir. Certainly, they could, and I would hope they would.

Q. *But even if there were matters of security, couldn't the companies sell boosters if the vehicles were launched in the U.S., with proper security measures?*

A. Yes, I don't see any reason why they should not or could not.

Q. *Would it be necessary for the U.S. to have any control over the payloads a foreign country launched with U.S. boosters?*

A. I think this could be established by a predetermined set of standards. We had better take these things on a piecemeal basis, examine them carefully and one at a time.

Certainly we wouldn't make available to a foreign country a booster to launch an atomic bomb just to further develop that country's technology in the development of nuclear energy. Of course not! In this instance we would say "No. We won't sell you one under any such condition." So I say we would have to give our assents on an individual-project basis.

Q. *Mr. Karth, is there now any effort to sell our heavy-thrust booster capabilities abroad?*

A. I know of no one who is looking into the proposition of selling them. That doesn't mean it isn't time we started thinking about it—and I intend to talk to people about this proposition and would hope that our government would give it serious consideration and weigh all the pros and cons.

Q. *Where do you feel the initiative lies to start a program of selling our space systems abroad? Should it be industry, NASA, Congress, the White House?*

A. I feel very strongly that some serious consideration should be given to it. I think maybe the Administration should first go through the exercise of looking into the merits and demerits. And this need not take forever.

This could be done by appointing a very select committee of NASA officials, DOD officials, State Department officials. I think industry should be represented on this board too, or on this select committee . . . call it what you like. And, of course, the Administration directly. And then some people from the scientific community, in general, could be called on for contributions.

Q. *How would we react if a nation wanted our boosters to launch its own system of communications satellites?*

A. If they are really serious about becoming engaged in this kind of a program, they are going to do it with or without us. I'd rather they did not develop all of these technologies themselves, but depend upon us to supply them. Nevertheless, if they want boosters for peaceful purposes, we ought to sell the vehicles to them as long as we can.

Here we are in a position to capitalize on our capabilities over a long period of time—probably for a decade or two decades—and I think we're acting like the ostrich with its head in the sand. When you've got an opportunity, I think you've got to exercise that opportunity, and here is an area where I think we have it. Here is an area where I think we should not go down the road of archaic-type thinking.

Good grief, we've never gone to the Moon before either, and if our thinking is that we shouldn't do anything we haven't done in the past—well, I guess we really wouldn't have a space program.

This is why I'm interested. It means jobs for American workers. It could mean a more favorable balance of payments. In fact it may be just what we need. And this means that a good deal of our outflowing of gold could be stopped. If these things are important, I see no reason why we can't embark upon selling our technology to those people who want to participate in a broadly based space program. ■

Policy Now Permits Sale of Scouts and Thors, But Not Atlas

"WE HAVE a policy which will permit the sale of *Scouts* and *Thors* to foreign nations, although no policy has yet been drawn up to allow the sale of *Atlas*," Arnold W. Frutkin, NASA's director of international programs, told MISSILES AND ROCKETS.

"Under a separate program," he said, "we use U.S. launch vehicles to place in orbit foreign experiments or satellites of mutual scientific interest without any exchange of funds. So far, only *Scouts* and *Thors* have been required."

The U.S. has made *Scouts* available to both France and Italy, a *Thor-Agena* to Canada for launching the *Alouette*, and a *Thor-Delta* to Great Britain for the *Ariel*.

The question of selling an *Atlas* launch was recently brought up by the interest of Boelkow-Entwicklungen K.G. of Ottobrunn, outside of Munich, in acquiring the launch capabilities of an *Atlas-Agena* to orbit the company's proposed 3,300-lb. German satellite (M/R, Aug. 5, p. 24).

A precedent supporting the use of booster capabilities for other than U.S. government purposes is the launch of the *Telstars*, under an arrangement with American Telephone and Telegraph Co. AT&T, in this instance, bought the *Delta* launch vehicles and associated services from NASA.

• The soft sell—The missile/space industry is predictably eager to sell its space products abroad. And several companies have mildly complained of security restrictions preventing them from going all-out to sell in the European market. Complaints would be louder, some company representatives admit, if they were not fearful of alienating U.S. customers.

A seasoned observer noted that U.S. security restrictions can not stop a European country from launching a satellite if it is determined to do so. Italy, for example, could have modified a U.S.-furnished *Jupiter* to orbit a payload. And Britain, when it gets the *Polaris*, will technically be able to put a third stage on the missile for orbital capability.

Meanwhile, European countries are developing their own capabilities, through the *ELDO* rocket of the European Launcher Development Organization; the *Diamant* in France; and the *Blue Streak* (ELDO first stage) in Britain.

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For design manual, write Dept. 6220, Engineering Products Div., Dow Corning, Midland, Michigan.

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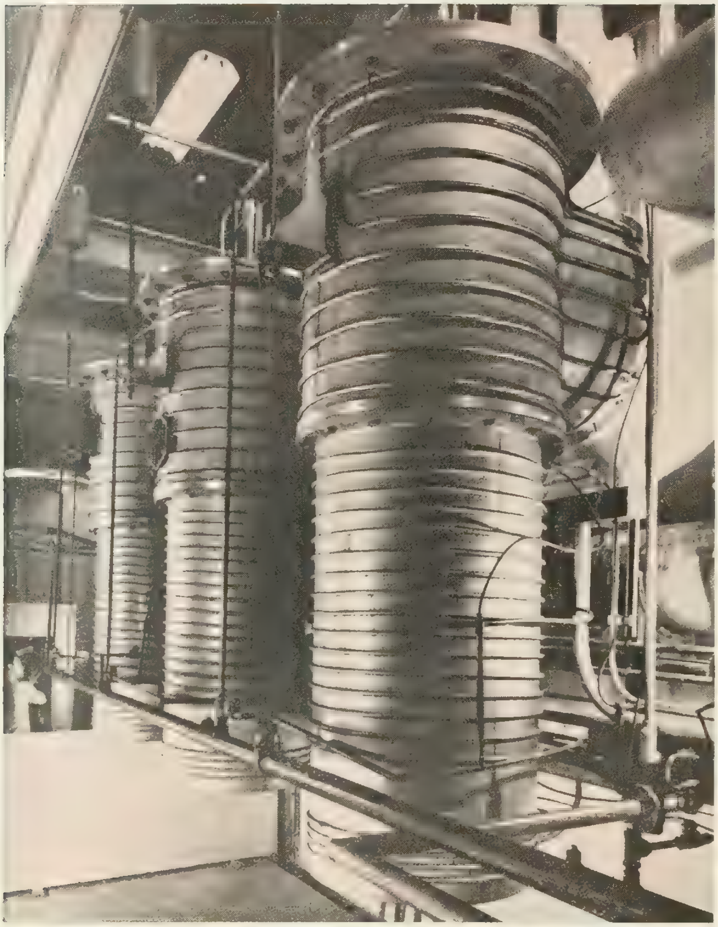
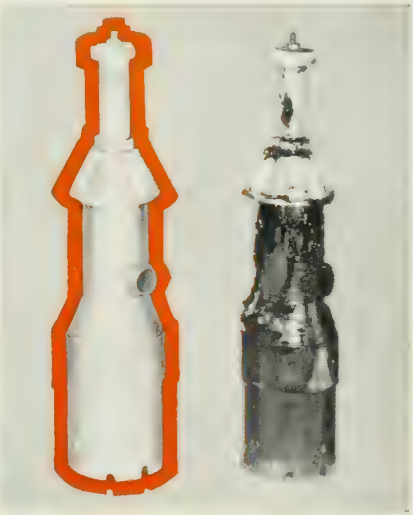


◀ Six of these giant 32-inch diffusion pumps evacuate the 3,000 cubic foot, high altitude-temperature space chamber at the new Space Environments Laboratory of Fairchild Camera and Instrument Corporation's Defense Products Division, Syosset, New York. Designed for testing vehicles, systems and sensors in environments simulating altitudes up to 380 miles, at temperatures from —100 to 300 F, this ultrahigh vacuum chamber has achieved a pressure of 4×10^{-9} mm Hg. Dow Corning Diffusion Pump Fluid was chosen to achieve the ultrahigh vacuum required in this system.

New silicone fluid produces pressure in the range of 2×10^{-10} Torr...

Now, ultrahigh vacuum can be achieved . . . without refrigeration . . . by specifying the new silicone diffusion pump fluid, Dow Corning 705. New Dow Corning 705 makes possible the attainment of vacuua to 2×10^{-10} Torr . . . even higher vacuua with refrigeration. In addition, it offers the exceptional properties unique to all Dow Corning silicone diffusion pump fluids. These include:

Greater stability. Dow Corning silicone fluids offer superior resistance to oxidation . . . will not decompose into gums or tars or lose vacuum pumping properties. They recover 15 to 20 times faster than conventional organic fluids after exposure to air, and eliminate the need to cool pumps before releasing vacuum.



Cleanliness. Breakdown tests on pump fluids were made with diffusion pump jet assemblies. The encircled jet shown was cycled 1,100 times with a Dow Corning silicone fluid. Organic fluids in other pump failed much earlier.

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Technical Countdown

ELECTRONICS

Satellite-to-Satellite Communications Studied

Air Force Cambridge Research Labs has begun a series of atmospheric rocket probes as a part of a new satellite-to-satellite radio-propagation measurement program. First launch of an instrumented package was made successfully on July 25 from Eglin AFB, using an *Exos* rocket. The 100-lb. payload, developed by GE's Advanced Electronics Center, Ithaca, N.Y., for AFCRL, reached an altitude of 230 n. mi. and impacted 118 n. mi. down range.

Complex RF Signals Separated

Classified equipment developed by Stanford University permits extraction of intelligence from scrambled signals or detection of signals immersed in noise. It uses filters that adjust automatically to particular features of incoming signals. Each filter captures one pulse train, having a uniform characteristic, from a complex signal. Incoming signals enter a measuring transducer that converts a selected parameter —such as pulse width, frequency—into an equivalent voltage. By paralleling many transducers, critical parameters can be examined simultaneously. Sampling time is about 4 μsec. and a filter can capture a signal in 5 μsec. Once a part of a complex signal is captured, the other filters ignore it and search for other regular features. By adding more transducers and filters, very powerful signal detection and analysis systems can be obtained.

EM Stabilization Applications Cited

Electromagnetic techniques for space-vehicle attitude-control systems someday may provide all the control torques necessary for the life of a satellite. A. G. Buckingham, of Westinghouse Electric Corp., says present plans for use of EM control torques include removal of wheel-stored momentum, generation of position-control torques, and precession of a spinning satellite. Such actuation systems, he claimed, could remove initial vehicle rates within five orbits and erect a vehicle to the local vertical. Performance, in general, would be improved through the use of nonlinear control techniques.

RCA Announces All-Purpose Computer

The first commercial computer system believed capable of performing all the electronic data-processing functions necessary to any firm was described to industry and press representatives by Radio Corporation of America last week in Washington. Called the RCA 3301 REALCOM, it can perform up to five EDP operations simultaneously, although actual computation is performed on a time-share basis. An extremely flexible modular system, it can handle scientific, serial, random-access, and integrated communications services and provide real-time operation. Up to six data-disc files (88 million characters/file, 100 msec. access time) and 24 magnetic tape stations on line can be accommodated. The 3301 processor has a 160,000-character memory and a 1.75 μsec. cycle. A minimal complex to handle the four primary EDP functions will rent for about $40,000/month, RCA officials stated.

And CDC Unveils a New Scientific Computer

Control Data Corp. demonstrated its newest scientific computer last week, the 6600. Described by the Minneapolis firm as the fastest, largest-capability computer in existence, it can execute an average of over 3 million instructions/sec. An all solid-state system, the 6600 employs a 131,072-word core memory that uses silicon components throughout the logical elements.

ADVANCED MATERIALS

Acoustic Siren To Jar Saturn V Launcher

Acoustic stresses in materials and equipment induced during a *Saturn V* launch will be simulated in part by the output of a huge siren able to generate 172 decibels of sound of the random type. Energy evolved is a million times more powerful than the threshold of pain to the human ear. Developed originally by the Martin Co. to simulate the tremendous acoustic pressure created by *Titan II* when it is ignited within its underground launcher, the siren facility is expected to be used first on materials used in the *Saturn V* launcher. Another possible use involves the rooms within the launcher, which house delicate electronic equipment to be used in checkout and launch. (See photo, p. 27.)

ASTRONAUTICS

New Solar Plasma Evidence

Streams of plasma issuing from the Sun are blowing on Earth many days after the cause of these streams has passed, causing magnetic storms and a change in the cosmic-ray pattern on Earth. Although existence of long-lived solar plasma streams was postulated 33 years ago, the new evidence verifying their existence is based on *Explorer XII* data, analyzed recently by a team of Goddard scientists. They point out than the first of a long-lived plasma stream was observed by *Explorer XII*, emanating from an area which produced a solar flare on Sept. 28, 1961. Two days later, the plasma stream reached Earth, causing characteristic disturbances. Similar disturbances occurred on Oct. 27, 1961, without having been preceded two days earlier by a solar flare.

SPACE MEDICINE

Photosynthesis Studies Funded

Scientists at Martin Company's Research Institute for Advanced Studies will continue probing for the basic mechanism of photosynthesis under a $48,753 grant from NASA. Program is under the direction of Dr. Bessel Kok, who isolated the single chlorophyll pigment in plants believed to be the final collection point for incoming light and the energy catalyst in the reaction. Other areas of study include the effects of light color change and intensity on algae and other plants, plant respiration and the study of chloroplasts.

NASA Lab Synthesizes Chief Energy Molecule

Adenosine triphosphate (ATP), the molecule which is the major source of chemical energy in living organisms, has been synthesized by NASA scientists, headed by Dr. Cyril Ponnamperuma, at Ames Research Center. The molecule produces chemical energy through the products of an organism's oxidation of nutrients. It was synthesized by shining ultraviolet light on a chemical soup. This may change NASA's approach in the search for higher forms of extraterrestrial life, since heretofore it was thought that these chemicals were found only in the presence of life.

Military ComSat Desires Disclosed

Aerospace tells WESCON of special defense needs in medium-altitude system; maser progress reported

San Francisco—A report on active communications satellites has provided some insight into selection criteria for the medium-altitude ComSat system now under development for the military.

The study was presented at the Western Electronics Show and Conference (WESCON), sponsored by the Institute of Electrical and Electronic Engineers. It was prepared by a trio of engineers at Aerospace Corp., a DOD-created non-profit laboratory at El Segundo, Calif., responsible for systems engineering and technical direction for the military ComSat program.

The report illustrates the major design considerations and constraints imposed on development—including launch vehicle and satellite—by the need for very high reliability and early operational usage. As a result, the military has taken a medium-altitude, polar-orbiting, spin-stabilized satellite approach as the most feasible way to an initial operating system. This is in sharp contrast to the earlier complex, costly, and now "reoriented" *Advent* program.

In discussing ComSat design peculiar to military needs, Aerospace noted the need for operation with small transportable stations, the exclusion of satellite command link unless such a link is invulnerable to jamming, and the lack of a requirement for very large bandwidth in comparison to commercial systems. However, it added that satellite bandwidth should be made as broad as possible to permit use of spread-spectrum techniques in the presence of jamming.

Sophisticated stabilization methods, nuclear power supplies, and elaborate on-board data processing will not be included in early operational systems.

The fact that most likely military communications links are east-west favors polar orbits for best coverage. Another factor favoring polar orbits is the phenomenon of nodal regression—an effect due to the Earth's equatorial bulge which brings a gravitational torque to bear on satellites in certain orbits. This does not affect polar or equatorial orbits.

This effect would, however, preclude use of passive spin-stabilized ComSats in other orbits, introducing antenna stabilization problems.

For more advanced systems, passive gravity-gradient stabilization techniques, though not as simple and reliable at this point for operational deployment, could show significant improvement with higher antenna gains, (7-9db). Limitations to polar orbits do not apply for these devices, Aerospace says, but circular-orbit precision requirements would be more stringent.

- **Complications**—Probability of using the satellite system effectively and when needed is based not only on ComSat design but also on number of satellites, number of orbital planes, and altitude.

In a typical system, as outlined by the engineers, with 24 randomly distributed satellites in various numbers of orbits at a 5,000-mi. altitude, if the number of different orbits in which the satellites are placed is greater than three, "downtime—defined as the time when no satellite is mutually visible to two ground stations—is negligible."

Assuming a booster reliability of 0.7, a satellite orbital injection reliability of 0.8, launch of seven satellites per vehicle, and the capability of launching every six weeks, the satellite itself must achieve a life expectancy greater than one year to prevent satellites from failing in orbit at a rate greater than that at which they can be launched.

A practical satellite for this role, the report states, would weigh about 100 lbs., including an RF transmitter with about a 2½-watt output. According to the report, present military ComSats must be supported by solar-cell power, which is limited in output for a relatively small and lightweight satellite.

Because a spinning satellite must have an antenna pattern which is omnidirectional around the spin axis, the total antenna gain cannot be much more than that of an isotropic antenna.

The simplest form of satellite repeater, the report states, would consist basically of a microwave super-heterodyne amplifying the incoming signal (probably about 8,000 mc) at an intermediate frequency. The signal is amplified, reconverted to a microwave signal by an up-converter, and amplified by a traveling wave tube (TWT).

Because of multiple-access requirements for ground stations, it may be desirable to channel the IF amplifier into two or more separate frequency bands in which translated microwave signals may be amplified. In addition, to avoid "capture" of the satellite by a single, very strong signal during periods of multiple access in which other weaker signals are also being transmitted, some form of channel limiting is required within the ComSat to insure receipt of all data.

The simplest form of modulation, Aerospace reports, is wide-band fre-

Company Seminars Pose Problem for Sponsors

San Francisco—The four-day WESCON meeting at the Cow Palace was expected to draw more than 37,000—about 4,000 more than the last such gathering here.

More than 360 exhibitors were represented, and 79 papers were presented.

Company-sponsored seminars again presented a problem for IEEE officials, although the latter made no official statement concerning them. These seminars, held outside the auspices of WESCON, first took place in significant number at the IEEE meeting in New York last spring. Their number increased at WESCON. Many observers feel that some plan to deal with them and their effects on the sponsored meetings may be forthcoming before next year's IEEE meeting in New York. Plans could include integration of some of the seminars into the meeting program.

quency deviation. By employing a phase-lock or modulation feed-back receiver, the carrier-to-noise ratio can be as low as 6 db.

- **Maser devices**—The coming of age by very-low-noise traveling-wave maser (TWM) amplifiers in sufficiently simple packaging for space communication field-installation use was described by a team of engineers from Microwave Electronics Corp., Palo Alto, Calif.

Availability of these devices for field use is considered by many to be one of the keys to truly global deployment of ComSat stations—both for transportable military devices and for limited-budget, limited-traffic countries who wish to participate in commercial applications.

Improvements in closed-cycle refrigeration techniques for cooling the maser, refinements in critical-temperature performance of the TWM, and new antenna structural design, particularly the widespread use of Cassegrainian antenna-feed systems, have all contributed to availability of these devices.

Microwave Electronics reports it has developed and successfully operated two TWM's using a 4.2° K refrigeration system developed by Arthur D. Little, Inc., Cambridge, Mass.

One unit, operating at S-band, was developed for Jet Propulsion Laboratory and is now operating at its Goldstone Deep Space Instrumentation Facility.

This amplifier has a center frequency of 2,360 mc with a tuning range of 150 mc. It reportedly gives gains in excess of 26 db, an instantaneous bandwidth greater than 16 mc, and a noise temperature of 13° K.

The second unit is an X-band amplifier, proposed for radio astronomy and telemetry roles, with a center frequency of 8,000 mc and a 300-mc tuning range. Gain over this tuning range is said to be about 25 db, with a noise temperature of 12°K.

The X-band device uses a 15-lb. superconducting elemetromagnet in lieu of the 680-lb. permanent magnet used in the S-band configuration. The introduction of superconducting magnets into TWM design has been one of the major factors allowing development of compact TWM's for small field antennas and some airborne applications.

- **DTL for Minuteman**—Nand gate logic configuration implemented by diode-transistor logic (DTL) has been chosen for the integrated circuits of the improved *Minuteman* computer and flight control system. Reasons given by North American Aviation for selection of DTL are simple and familiar circuit form, good noise-rejection characteristics, low power consumption, and adequate speed.

For encapsulation of the integrated circuits, a flat rectangular package will be used in preference to the standard TO-5 transistor can.

Forced liquid cooling will be used.

Circuit packages will measure 1/8 in. by 1/4 in. by 1/32 in. and will have external leads of flat ribbon kovar, 0.002 in. by 0.13 in.

Laminated boards, containing 10 layers of conductors for interconnections, each will carry up to 180 circuit packages.

Connections to the integrated circuit leads will be made by a lapsoldering technique. Internal connections to the silicon chip, mounted on a high-alumina substrate, will be made by a thermo-compression ball bonded in 0.002-in. gold wire.

The flight control unit and the inertial measurement unit contain several linear integrated-circuits. Most frequently used circuit is a high-gain linear amplifier. This will also be adapted to other forms of d-c and a-f amplification by addition of passive external circuits.

Other external circuits will convert the amplifier to a multivibrator or a pulse-width modulator.

The external resistive circuits are to be of the ceramic printed-circuit type. These have a high-alumina ceramic substrate with standard dimensions of 0.75 in. by 1.5 in. by 0.030 in. Resistive elements are deposited on the substrate through a screen and fixed by a firing process.

In the computer unit, integrated circuits displace 93.6% of the discrete components. In the inertial measurement unit, integrated circuits displace 45% of the discrete units and ceramic printed circuits displace 28%.

- **PCM encoder**—Evolutionary development of an integrated-circuit Pulse-Code-Modulation (PCM) encoder is being carried out at Texas Instruments. Following construction and testing of a discrete-component encoder, circuits in this were replaced individually by equivalent integrated circuits as they became available.

The final packaged unit now occupies 15 cu. in. and is 50 times lighter than its conventional counterpart.

It contains about 150 digital integrated semiconductor networks and 200 linear and passive integrated networks.

With full integrated-circuit complement, the encoder performed in a manner identical to that of the original discrete-component unit. Performance data were taken over a −55° to +71° C temperature range.

The encoder consists of 16 analog and 5 digital input channels, each providing eight bits of information and two bits of word synchronization. The system output is an NRZ pulse train at a 200-kc bit rate.

To reduce bandwidth requirement, gray code was chosen in preference to binary code. Digitizing time for the integrated circuit version is 18 microseconds, in comparison with 8 microseconds for the conventional versions.

A very stable reference voltage for analog-to-digital conversion was achieved by use of temperature-compensated Zener diodes on a substrate controlled to a constant 90° C. Total variation of Zener voltage over a −55° to +71° C temperature range was 0.01%.

Massive Siren Used in Saturn V Acoustics Tests

ENGINEER CHECKS alignment of siren, most powerful of its kind, used in NASA acoustics test on Saturn launcher structures at Martin-Denver (see p. 25).

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- **P-most transistors**—A device offering ease of logic design in digital systems comparable to that of the conventional relay is being developed by Fairchild semiconductors. It is called the field-effect hole-conducting metal-oxide-semiconductor transistor (P-most).

A similar device being developed by Pacific Semiconductors is called the insulated-gate field-effect transistor.

In spite of the complexity of their names, these devices are very simple in structure and have stable, reproducible characteristics. They operate in an enhancement mode and can be directly coupled without the use of level-shifting resistors.

Gate input impedances to these devices are greater than 10^{15} ohms and their input capacitances are less than 2 picofarads.

Another advantage these devices have is that they can be diffused into silicon wafers in large arrays without isolation problems.

Their immediate application is in digital circuits, and Fairchild has developed a simple inverter containing one P-most. In response to an input pulse with a 1-nanosec. rise and fall time, the inverter output rises in about 1 nansosec. and falls in 10 nanosec. If 25 P-most gates were driven by this inverter, its fall time would increase to 150 nanoses.

Pacific Semiconductors believes this device also has considerable potential in hybrid analog-digital systems.

The device is formed by diffusing two adjacent P-type islands into an N-doped wafer. Junction depth and the resistivity of the P-type material are not very critical. A thin silicon-dioxide insulating layer is then grown over the area between the diffused P-regions.

Contact holes are etched through the oxide and metal is vacuum-deposited over the surface of the wafer in a pattern that provides an insulated gate electrode over the region between the two P-regions, and also two contact electrodes to these regions.

One of the P-regions is called the source, the other is called the drain. Current flow from the source to the drain is governed by the potential between the gate and the base material, which is externally connected to the source.

Negative bias to the gate repels electrons from the N-region below the gate and attract holes. If the gate is made negative enough, the N-type silicon below the gate will convert to P-type in the region close to the oxide film, so that there will be a low impedance path from source to drain.

Present devices fabricated at Fairchild Laboratories are 250 microns long, have source-drain spacings of 5 microns, and oxide thicknesses of about 1,000 Angstroms. Standard photolithographic, etching and diffusion techniques are applied during fabrication.

An operating temperature range of −200° to +200°C is quoted for these devices and large temperature differentials are permissible between various parts of an array of circuits. Consequently, very high packing densities are expected.

- **Welding mode scored**—Parallel-gap welding in production-line assembly of integrated circuit packages was criticized by Sippican Corp. Chief drawback listed was the need to control everything in the welding cycle to very close tolerances. Another disadvantage quoted was that the parallel-gap weld is still very sensitive to the energy delivered because of the need for limiting the depth of current penetration in thin materials.

One parallel-gap welding firm was quoted as expecting 8 out of 100 welds to be visual rejects.

As an alternative to this process, Sippican is developing an operational laser welding machine. The small spot size of the laser beam should be excellent for welding closely-space integrated circuit arrays from one side.

Sippican has packaged 272 Texas Instruments integrated circuits in a total volume of 9.3 cu. in. Dimensions of the package are 2.06 in. by 2.25 in. by 2.00 in. Eight modules, each containing 34 integrated circuits, make up the complete unit.

- **Cheaper circuits**—A low-cost method of fabricating integrated circuits was described by International Business Machines Corp. Hybrid integrated circuits (semiconductor chips and deposited passive components) are produced in this method without the use of thermocompression bonding and without hermetic sealing.

An and-or-inverter logic block with an average logic delay of 20 nanosec. has been fabricated by this technique.

The epitaxial silicon devices used in the circuits are 25 mils square and are sealed in high-temperature silicate glass.

Conventional evaporated metal electrodes on the silicon devices are contacted through holes in the glass by fused metal balls. Both electrical contact and mechanical attachment are achieved by fusing the balls to the module substrate.

Temperatures above 300°C are reached during fusion without damage to the diodes or transistors.

Substrates are of 95% alumina and measure 0.445 in. by 0.455 in. by 0.060 in. thick, carrying pins for interconnection to other substrates.

Printing of resistors and interconnecting leads on the substrate is carried out by stencil screening techniques, fol-

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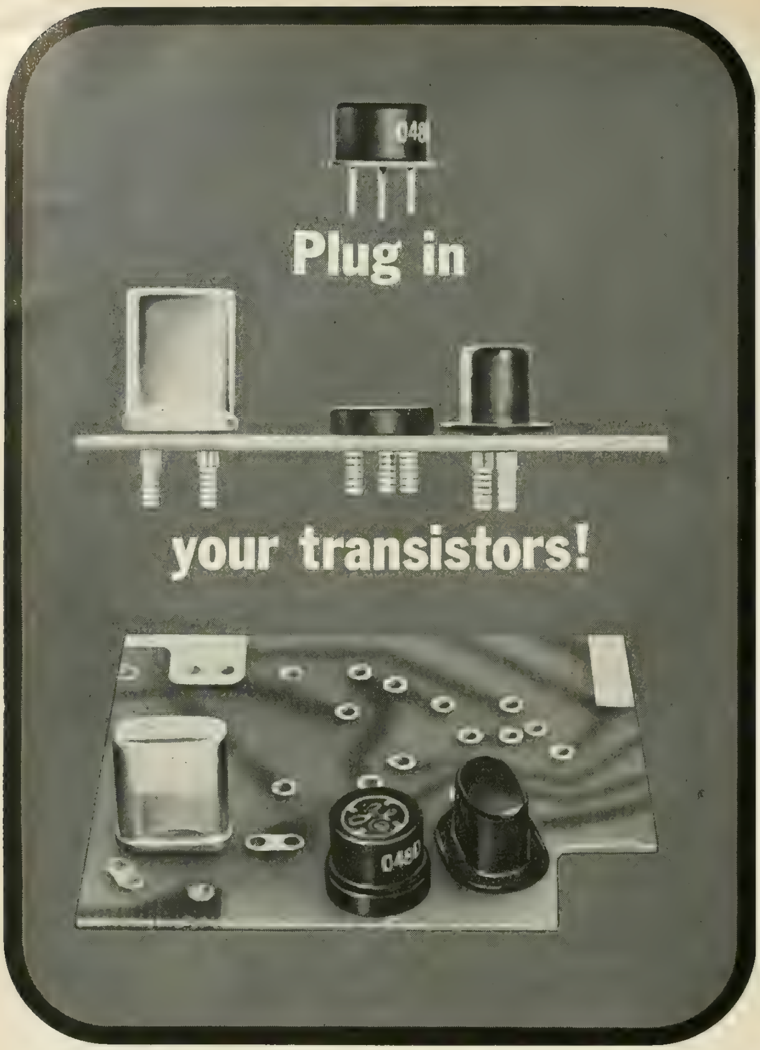

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lowed by firing at 750° to 800°C. Tailoring of resistors to within 1% of the required value is achieved by sand blasting, before attachment of the active devices.

For attachment, a chip is held in position by flux and heat is applied to the substrate to melt the solder ball. Modules are subsequently coated with plastic to reduce corrosion of solder lands.

• **Thin-film devices**—Laboratory production of thin-film junction diodes with breakdown voltages of 60V and forward currents of 30 ma at 1V, and of thin-film transistors with current gains of up to 200, were reported by Sylvania Electronic Systems.

The devices were formed in chemically-deposited films by photolithographic techniques and in vacuum-deposited films by silicon deposition through molybdenum masks.

Elimination of the interfering effect of uneven polycrystalline substrate structures was achieved by coating the substrate surface with oxides that are molten at the deposition temperature of the semiconductor film. Deposition therefore takes place on a level fluid surface.

Chemical deposition is carried out by hydrogen reduction of silicon tetrachloride, in equipment similar to that used for epitaxial growth. Vacuum deposition is carried out in a stainless-steel vacuum chamber by electron beam evaporation of silicon at 10^{-6} torr.

A wafer containing 18 diodes, making up three And gates, was formed by depositing six films of P-type material and then depositing three films of N-type material on each of these six. Misalignment of the film edges was made to enable electrode connection.

• **HF transistors**—An analysis of optimum transistor design for high-frequency operation, presented by J. Gerald Bouchard of Sprague Electric Co., Concord, N.H., concluded that "for each transistor type, there is but one set of design variables which yield maximum high-frequency power gain."

Furthermore, Bouchard states, "it has been shown that contrary to previous theory, PNP transistors are capable of greater high-frequency gains than NPN transistors."

The reason for this, he reports, is that in very-high-frequency transistors, the base minority carrier mobility is only a second-order effect in determining the high-frequency power gain; whereas the majority carrier in the base is a first-order effect. "For this reason," Bouchard told the meeting, "it is expected that the high-frequency noise figure of PNP transistors will be considerably lower than PNP transistors." ■

THE NEW CRAFTSMEN Fingers are not made for sensing millionths of an inch. Nor can the eye discern such tolerances. Yet every day the production workers of today's aerospace industry turn out instruments and components which are accurate to the millionth degree.

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PROGRESS REPORT ON STORABLE LIQUID PROPELLANT ROCKET ENGINES AT UTC

Projected space missions involving upper-stage storable liquid propellant rocket engines impose certain rigid performance requirements:

1. The propellant must be space-storable. Future flights will last for weeks or even months, and most conventional earth-storable propellants can seriously deteriorate before the missions are completed.
2. Engine weight will be critical, particularly when the task involves orbital rendezvous.
3. Specific impulse must be improved over the current performance level of earth-storable propellants.
4. Variable thrust control will be required for maneuverability in space.

■ At United Technology Center we are now devoting major efforts toward development of engines to meet these demanding performance requirements.

■ New fluorine-based propellants, proved in more than 20 recent test firings at UTC, provide 20-25% higher I_{sp} than conventional fuels; and these new propellants are storable in space.

■ Engine weight has been reduced significantly by using filament-wound propellant tanks and highly efficient ablation-cooled thrust chambers. (Our recent test-firing using ablative chambers with fluorine-based propellants is an industry first.)

■ We have developed engines of various sizes which will stop and start in space, and which have thrust control over a range of 1 to 100. The advanced throttling techniques use aeration and variable area injectors.

■ In addition to our work in liquid engines, we are developing hybrid rocket engines which will combine the best qualities of both solid and liquid propellant engines. And UTC is the prime contractor for the first stage of the Air Force Titan III C, which includes two 120-inch diameter segmented solid rocket motors. Together, these motors will generate over 2 million pounds of thrust at lift-off, more than 80% of the vehicle's total thrust.

■ UTC's Sunnyvale headquarters have recently been enlarged and the Coyote Development Center's facilities are modern and extensive. Our 2,500 people provide us with a reserve of experience and talent. We have the men and machinery. This manpower and these facilities are devoted to advancing the state of the art for space propulsion.

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2

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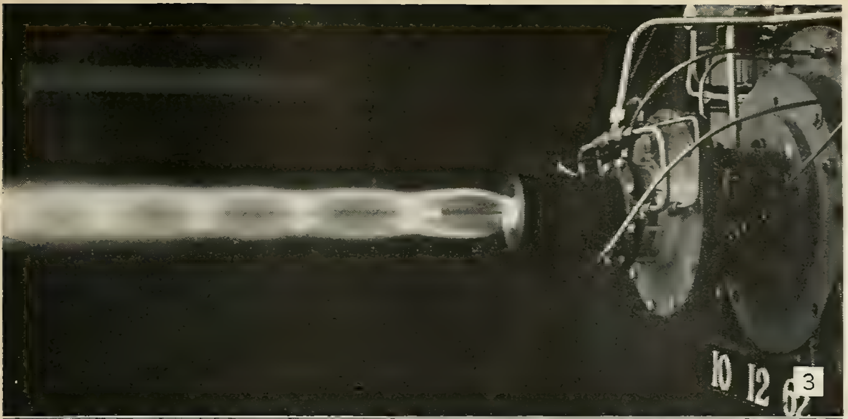

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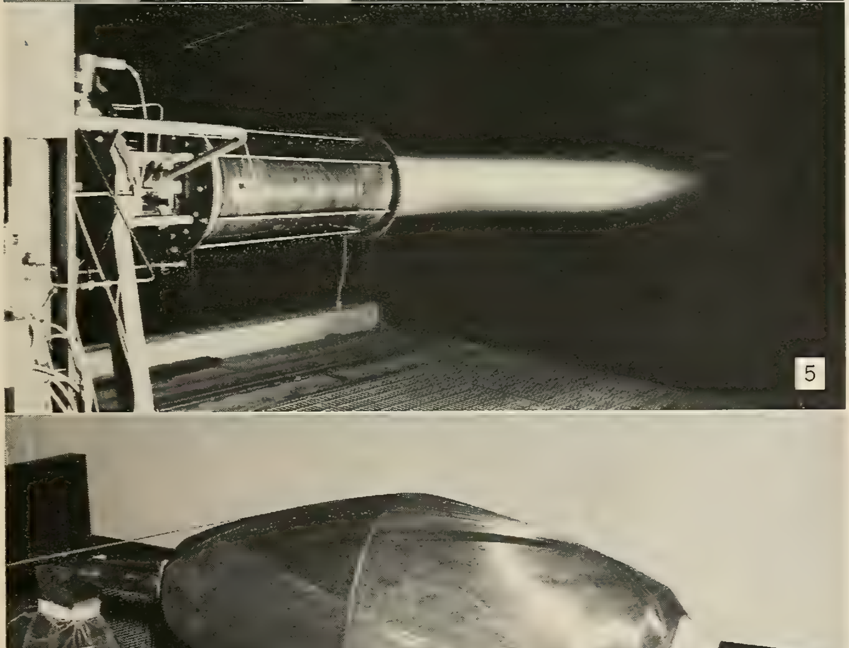

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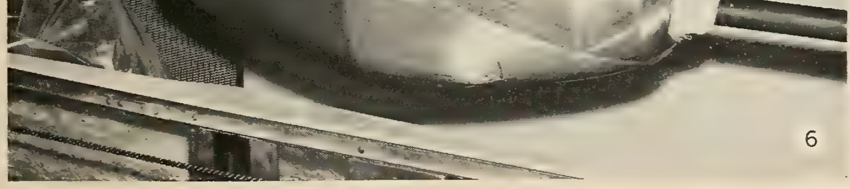


6

1. ABLATION-COOLED THRUST CHAMBER literally boils off its liner in order to cool itself. Ablative liners eliminate heavy, expensive tubing required for regenerative cooling systems.

◆

2. VARIABLE THRUST CONTROL over a 1 to 100 range is now possible with UTC's technique of aeration. Conventional propellant injection (top) does not allow reduction of rate of flow without danger of unstable combustion. Aeration throttling (below) diffuses propellant and gives precision control.

◆

3. SPACE SIMULATION TESTS prove the start-stop capability of advanced liquid propellant rocket engines. Flight-scale engines are hot fired in our test cells.

◆

4. OVER 3,000 TEST FIRINGS have already been conducted at our three major test stands.

This picture shows an engine using new fluorine-based propellants.

◆

5. EXTENDED DURATION FIRING of lightweight storable liquid propellant engine achieved stable combustion and high efficiency over a period of almost twenty minutes in a recent test at UTC.

◆

6. GLASS FIBER FILAMENT WINDING, a weight-saving fabricating technique, is being used for liquid propellant bottles for upper-stage engines.

Fuel Cell Readied for Orbital Test

Allis-Chalmers unit, which already has passed zero-g tests, uses hydrogen and oxygen together with 'capillary membrane' for static water removal

A FUEL-CELL SYSTEM will soon go into an Air Force satellite for what probably will be the first sustained orbital test of such a functioning power unit.

Designed to generate ultimately upward of one kilowatt for space missions of up to several weeks' duration, this fuel cell is expected to be the forerunner of modules leading to higher-power systems.

Using hydrogen and oxygen as its fuels, and known as a "capillary membrane" system, the cell last month passed extensive zero-gravity tests in a KC-135 aircraft at the Air Force's Aeronautical Systems Division, Dayton, Ohio.

Chief advantages of the device are its static removal of product water, high reliability through a partly static system of thermal control, and low specific weight of 50 lbs. per kilowatt, exclusive of the weight of the reactants.

- **Claimed most advanced**—This package, publicly disclosed earlier this month in Washington, D.C., "is the most advanced experimental hydrogen-oxygen fuel-cell system so far developed for space application," said John L. Platner, manager of the Space and Defense Sciences Section, Allis-Chalmers Research Div., Milwaukee, which developed the fuel cell. It is a 28-volt d-c system, comprising 35 cells connected in series, capable of producing one kilowatt of electricity.

Because waste moisture is removed in vapor form, "40% of the cell's waste heat would be exhausted directly into space along with the vaporized water," Platner explained. The method was developed under contract to the NASA's Marshall Space Flight Center, Huntsville, Ala.

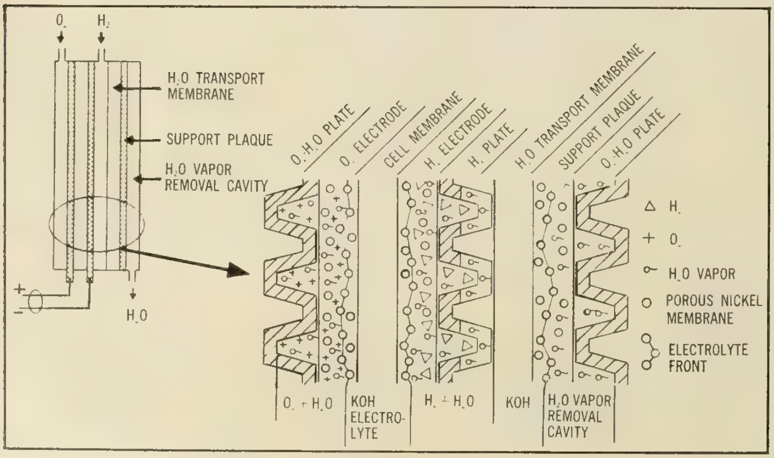


DIAGRAM of static-vapor-pressure-control fuel cell.

This moisture removal system thus reduces the heat burden imposed on the space vehicle's heat rejection system. Since the removal system is static, it is said to result in more reliable fuel-cell operation because "it eliminates moving parts such as recirculating pumps, condensers and water separators—'power parasites' characteristic of moisture-removal systems developed previously."

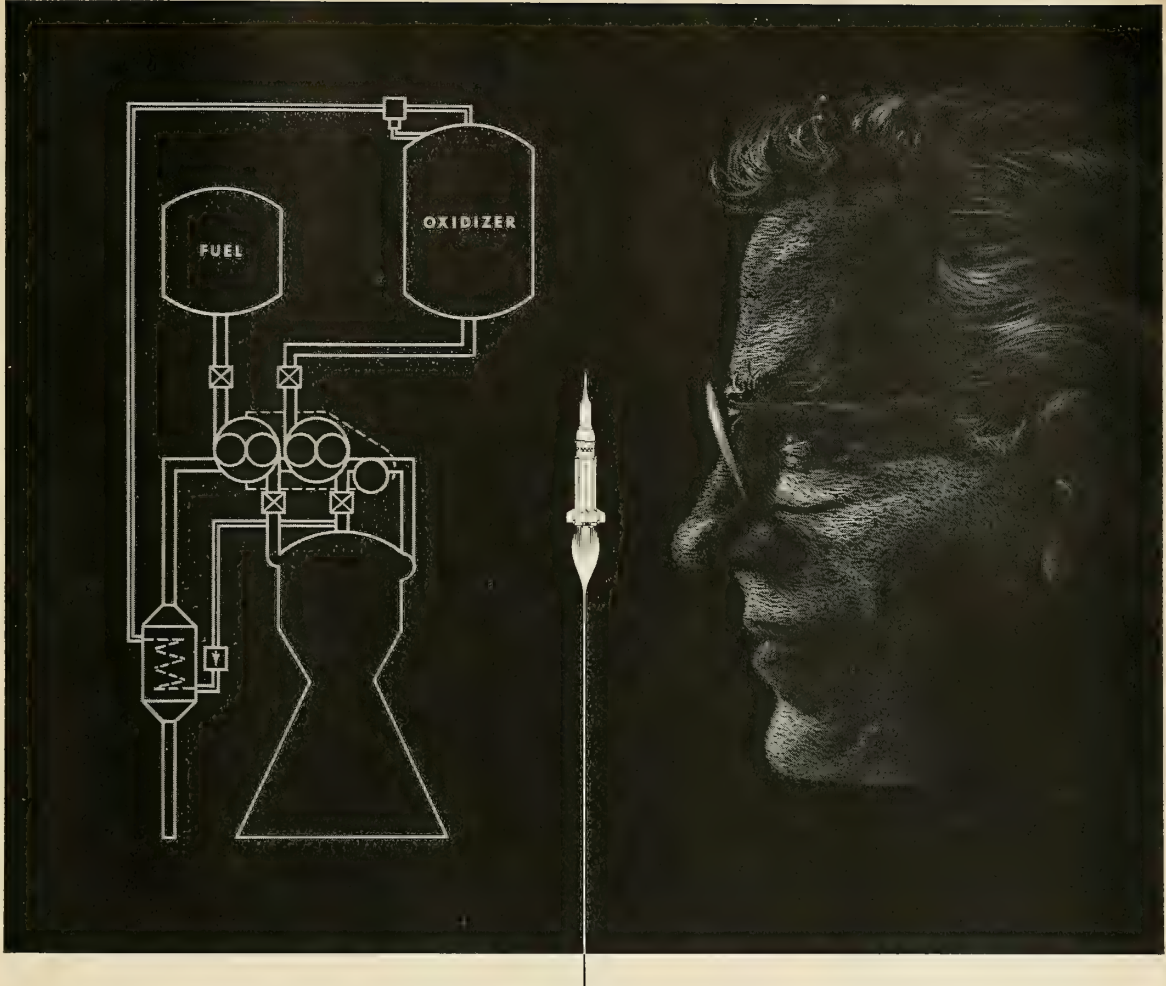
If astronauts need the waste water for drinking purposes, it can be recovered and "the system would not show its thermal advantage but would retain the advantage of system simplicity," Platner told MISSILES AND ROCKETS.

Allis-Chalmers claims that its fuel cell uses the first "static, vapor-pressure-control method" for getting rid of water.

Pratt and Whitney, builder of the fuel cell for *Apollo*, uses a recirculating hydrogen system to remove water and heat through a heat exchanger.

General Electric, developer of the *Gemini* fuel cell, uses a passive water transport system that condenses the product fuel-cell water on the oxygen-side current collector. The water is then carried through a wicking system to a water-oxygen separator. In this way, the oxygen is not carried over into the water ultimately destined for the astronauts.

- **Role of membrane**—The capillary membrane fuel cell consists of two porous nickel electrodes separated by a capillary membrane that holds a potassium hydroxide (KOH) electrolyte. Nickel-plated magnesium plates, used to support the electrodes, contain passageways to supply hydrogen and oxygen to the cell. Electrical energy is produced



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and reactants are consumed only when an external load is connected across the cell.

The unique feature of this cell is the capillary membrane. The capillary potential of the membrane, defined as the differential pressure required to force liquid from its largest pore, is in excess of 100 psi. This property enables the membrane to hold the electrolyte in proper contact with the electrodes regardless of their position, produces a uniform separation of the electrodes and of the reactant gases, and allows communication of water and hydroxyl ions between the electrodes.

The asbestos capillary membrane is completely filled with electrolyte during assembly; when it is compressed some of the electrolyte is forced into the electrodes forming the necessary interface of the electrolyte and catalyst. The difference in capillary potential of the asbestos and the electrode maintains the electrolyte front.

When the cell is constructed, a volume of electrolyte is chosen that will maintain the front at about one-third the electrode thickness. In this way, the additional volume in the electrode provides a reservoir for storage of product water and electrolyte when the cell is carrying an electrical current. The reservoir is an important feature of this type of cell in that it allows operation of the cell throughout a range of electrolyte concentration without an appreciable effect on performance.

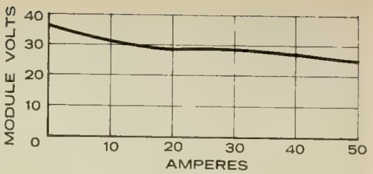
As water is produced in the cell, a reduction of the electrolyte concentration results. Best performance is obtained between 33% and 38% KOH.

For a given concentration of KOH, the water-vapor pressure in the adjacent reactant-gas cavities will be related to the temperature of the electrolyte. For a given temperature, the vapor pressure increases with a reduction of KOH concentration. The water vapor molecules seek equilibrium with the reactant-gas molecules in the gas cavities, and the sum of the partial pressure of the gases in a cavity equals the total operating gas pressure of the cell.

- **Static vapor pressure control**—The increase in vapor pressure, at constant temperature, with a reduction of electrolyte concentration (from an increase in product water in the cell) provides the basis for the controlled removal of the product water.

Water removal is accomplished by positioning another asbestos membrane, a water-transport membrane, filled with KOH of a slightly higher concentration than originally in the cell, directly in contact with one of the reactant-gas cavities.

The KOH in this membrane absorbs some of the water vapor in the gas cavity. This asbestos membrane is backed up with a porous nickel support plaque; it is similar to the electrodes which serve as a reservoir for the volume change associated with a variation of KOH concentration in the water-removal membrane. Since the water-transport membrane is completely filled with liquid, the loss of reactant gas by diffusion into the asbestos is negligible.



CURVE of experimental unit performance.

The water that is absorbed in the water-transport membrane reduces the KOH concentration and increases the volume. The cavity adjacent to the support plaques is filled only with water vapor. The vapor pressure is related to the KOH concentration in the membrane and the cell temperature. When the water-cavity pressure is lowered to the desired vapor pressure, water is withdrawn as vapor from the cell.

Control of the KOH concentration in the two membranes, and of the water removal rate from the cell at a given temperature, is thus directly dependent on the cavity pressure.

The driving force for the operation of the system is provided by the differences in vapor pressure due to KOH concentration gradients that exist in the cell.

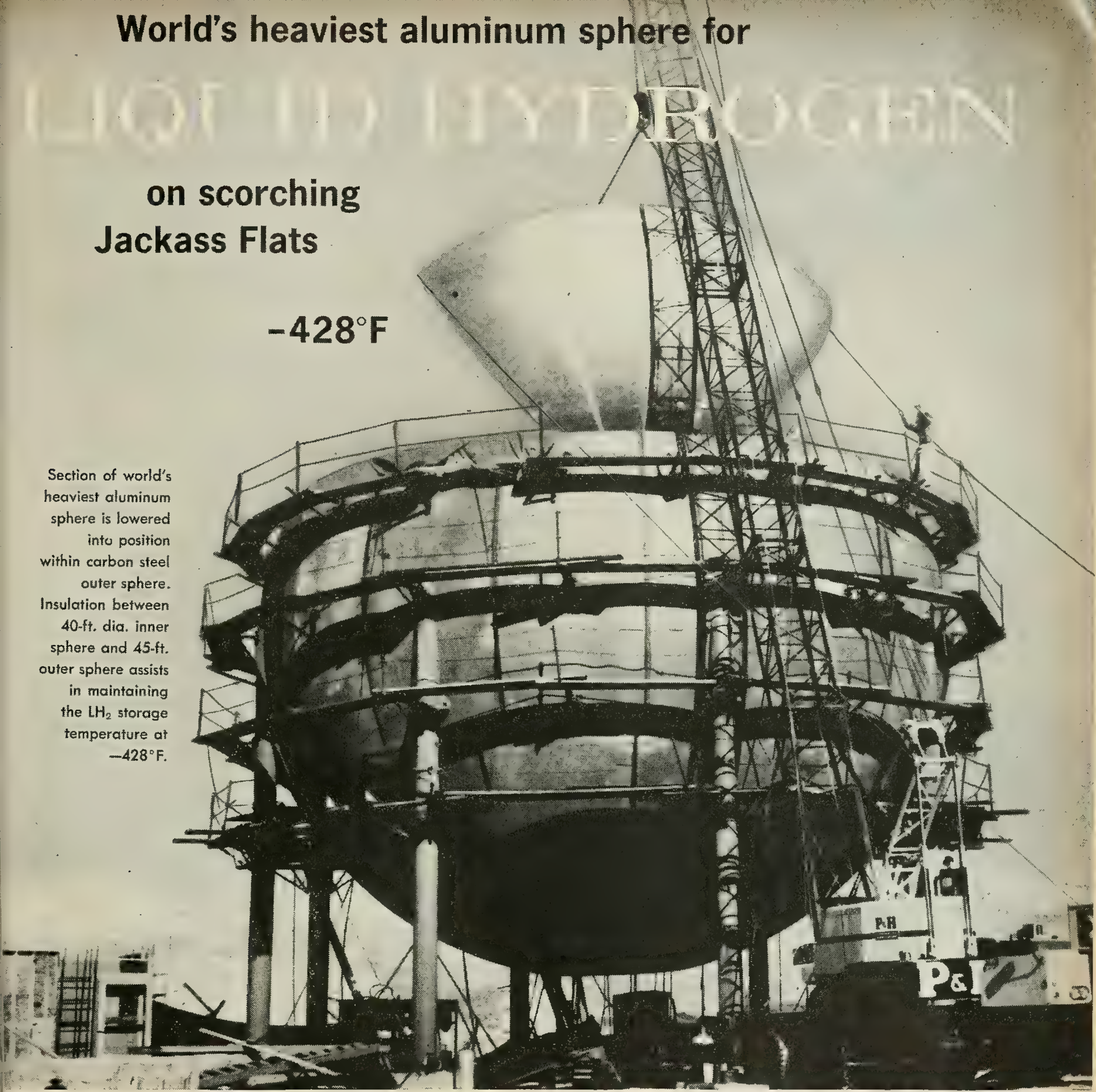
This system is said to be ideal for space applications. The water vapor would be exhausted directly to space vacuum with the only hardware requirement for the electrolyte-moisture-control-system being a control valve set at a relief pressure associated with the operating temperature.

The reactant gases are supplied to the cells in a "dead-ended" manner and require only an occasional purge dependent on the purity of the gases from the storage tanks. This is a completely static system with the only moving components being solenoid and regulating valves. The system lends itself to low-gravity conditions, since fluid transport occurs in the gaseous state and there are no free liquids or components dependent on gravity.

The static moisture removal system minimizes the problem of thermal control, because it vents water vapor directly to space vacuum. Therefore, a large portion of the waste heat is ejected from the system as the latent heat of vaporization of water. The amount of heat energy exhausted in this manner is in direct relationship to the amount of the water produced in the cell and to the cell temperature. ■

World's heaviest aluminum sphere for LIQUID HYDROGEN on scorching Jackass Flats

-428°F



Section of world's heaviest aluminum sphere is lowered into position within carbon steel outer sphere. Insulation between 40-ft. dia. inner sphere and 45-ft. outer sphere assists in maintaining the LH_2 storage temperature at −428°F.

CB-6222

The double wall, insulated Hortonsphere® shown under construction is for the storage of liquid hydrogen at a super-frigid -428°F amid searing desert heat. Inside the outer shell sits the world's heaviest aluminum sphere, the 65-ton inner vessel of this new cryogenic storage facility.

Designed, fabricated and constructed by CB&I for the Space Nuclear Propulsion Office, the Hortonsphere is part of the nuclear rocket engine (Project Rover) test facilities at the nuclear rocket development station at Jackass Flats, Nevada. Its frigid liquid hydrogen content will assist the joint AEC-NASA investigations of nuclear power for spacecraft propulsion.

A new welding technique used by CB&I speeded automatic butt welding of the 1½-inch aluminum plate during fabrication. With this method, only three or four passes per joint were required instead of the conventional twelve or more.

The utilization of such fabrication techniques—and often their development—is symbolic of CB&I's progressive leadership in the design, engineering, fabrication and construction of cryogenic installations.

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Oxidizer Additives May Boost RL-10 Power

WEST PALM BEACH, FLA.—Pratt & Whitney officials declare that the use of fluorine and additives in the oxidizer could increase the RL-10 engine trust level from 15,000 to 30,000 lbs.

The officials said that the increased thrust could be achieved if NASA has a requirement for it.

Study of the use of fluorine and additives is part of a comprehensive program to increase reliability and improve performance of the liquid hydrogen engine now underway at the firm's Research & Development Center.

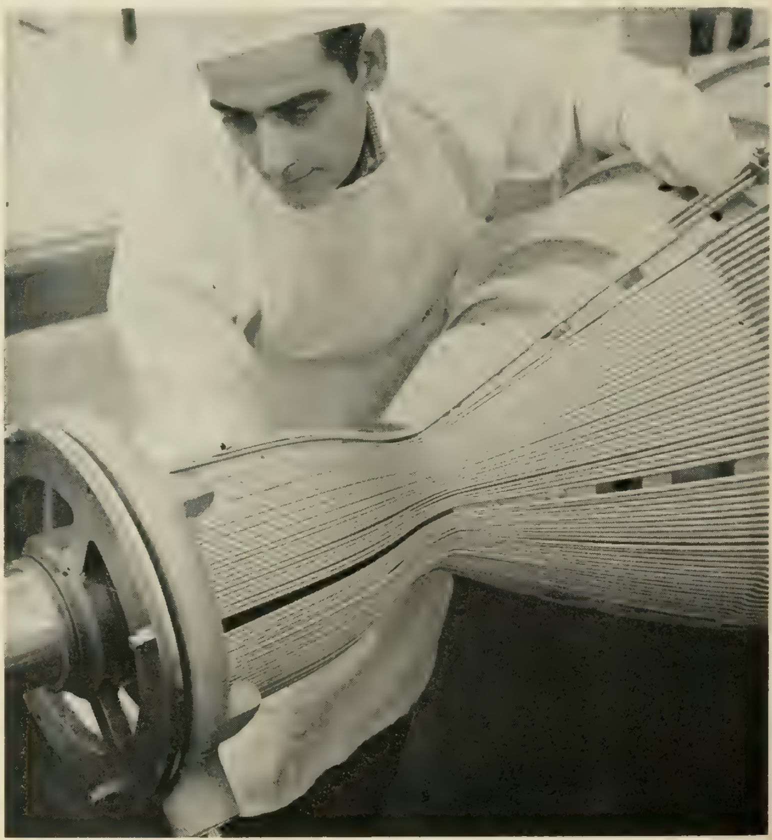
The RL-10, due to fly this fall on the *Centaur* and *Saturn* S-IV stages, has undergone one of the most extensive test programs ever conducted for a rocket engine.

W. L. Gorton, general manager of the plant, estimates the RL-10 has run more than 530,000 seconds on test stands and has burned more than 26 million gallons of hydrogen in the R&D effort to date.

Work on the RL-10 started in October, 1958, when P&W won a development contract. The engine completed its first preliminary flight rating test three years later.

First attempt to fly the RL-10 came with the May 8, 1962, *Centaur* launch. Structural failure aborted the flight and the engines were destroyed by a first-stage explosion.

Flight plan for the initial *Centaur*



TUBES on thrust chamber of RL-10 engine are assembled at Pratt & Whitney Aircraft's Florida Research and Development Center.

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Guidance equation mechanization for rendezvous and lunar landing • Orbit determination and correction, earth entry, and boost • Airborne guidance and control digital computer requirements and programming • Inertial guidance • Radar guidance (DSIF, Lunar landing doppler and altimeter, rendezvous radar, and recovery system) • Statistical error analysis techniques • Martian and interplanetary navigation.

STABILIZATION & CONTROL

Servomechanisms analysis • Advanced dynamics • Analog and digital computer simulation • Linear and non-linear systems analysis • Systems design analysis and mechanization • Sun seekers, horizon scanners, rate inertial gyros • Thrust vector control studies.

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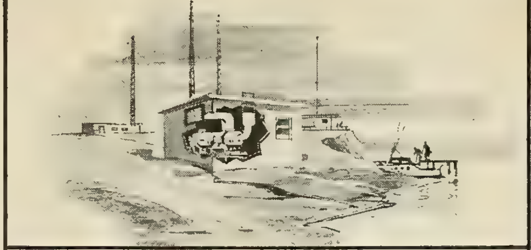
SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

Lightweight Emergency Power

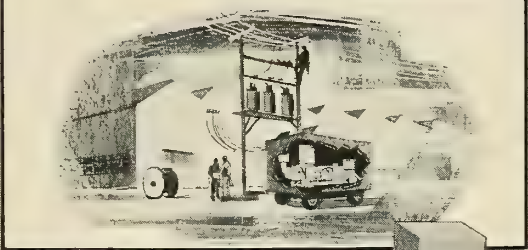
Gas Turbine Generating Set

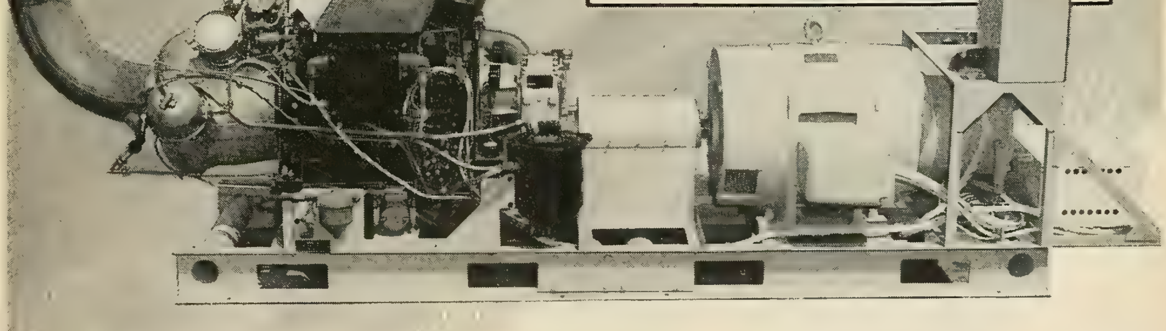
●

60 Cycle, 125 kw


Standby power

Paralleled primary mobile power


Emergency power



45 days delivery
High production, low cost
Fuel versatility; uses kerosene, JP4 or natural gas
Instant starting at temperatures from −65°F to +125°F
Small size, lightweight—under 2000 lbs
Accepts full load in 20 seconds
Two or more sets may be operated in parallel
Over 100 pounds-per-minute bleed air available

- The Garrett-AiResearch PGS-125 generating set requires no special installation. It is readily moved, and may be quickly separated into two parts for helicopter lift. Enclosure is optional. It is backed by AiResearch experience in building over 10,000 gas turbine engines. Parts and service are already available on a world-wide basis. For information on the PGS-125, or other available systems ranging from 30 to 300 kw, contact AiResearch, Los Angeles.

GARRETT

AIRESEARCH MANUFACTURING DIVISIONS • *Los Angeles 9, California • Phoenix, Arizona*
Systems and Components for:
Aircraft, Missile, Spacecraft, Electronic, Nuclear and Industrial Applications

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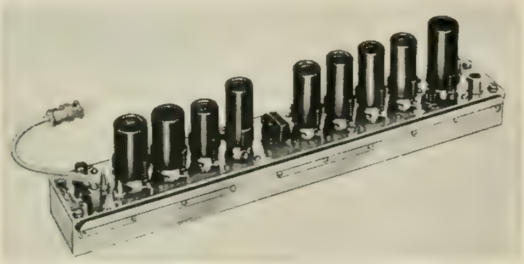
UNEQUALLED!

The **design** of RS Electronics miniature i.f. amplifiers has been widely imitated, but their **reliability** never equalled. After an RSE amplifier is placed in service, it doesn't come back for repairs.



RSE Model 905 miniature i.f. amplifier typically provides a noise figure of 1.5 db at 30 Mc center frequency with 110 db gain. Also available with 60 Mc center frequency.

RSE stocks a complete line of miniature i.f. amplifiers for off the shelf delivery, all built to military standards. The same applies to RSE subminiature i.f. amplifiers, which operate over a wide temperature range (—65° to +125° C). These units are unaffected by 100 g shock, 30 g vibration. RSE also offers high reliability transistorized i.f. amplifiers designed to meet all specs for airborne applications. Write us for complete details on all units. (Special requirements welcome.)

COMMAND WITH CONFIDENCE

RSE command receiver decoder package. Typical specifications: frequency, 406-549 Mc • sensitivity, five microvolts • RFI meets MIL-I-26600 • environment MIL-E-5422 E Class I • size and weight, 43 cu. in., 35 oz. • outputs, six independent commands.

Experience counts in command equipment. RS Electronics command equipment has been flown in thousands of flights, in both missiles and drones. RSE's complete line includes both tube and transistorized UHF FM command receivers, command decoders, telemetry and guidance transponders, and transmitters. Whatever your command application may be, up to the highest military standards, RSE can produce a unit suited for your purposes. Let us know your requirements.

RSE RS ELECTRONICS CORPORATION
a division of Pacific Industries, Inc.
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Circle No. 18 on Subscriber Service Card

called for a 15-min. ballistic trajectory impacting 1,175 mi. down the range.

Increasing confidence in engines and vehicles has caused NASA to order orbital injection of the *Centaur* and S-IV stages although neither has flown in space.

Present plans call for injection of the *Centaur* stage into an orbit ranging from 300 to 800 mi. The *Saturn* S-IV will be placed in a 150-500-mi. orbit.

- **R&D to continue**—Gorton said the current R&D program will not be curtailed if these first flights are completed without engine difficulties.

One principal effort will be directed toward increasing engine performance through use of fluorine and other high-efficiency propellants. Scientists also will try to increase versatility by discovering additives which will permit hypergolic starts.

Some of the work is being done under a recently awarded $980,488 NASA contract to study fluorine-oxygen mixtures and pure fluorine in combination with hydrogen for rocket propellants.

Bruce Torrell, program manager for the RL-10, said no particular problems are anticipated because fluorine additives have been used in company-funded studies as far back as 1958, when the first hydrogen-fluorine mixture was fired here.

"Very little modification will be required for use of fluorine in the RL-10," Torrell said.

"Burning fluorine with anything creates much higher temperatures but this is less of a problem with this engine than others because liquid hydrogen has an extremely high heat absorption capability.

"This engine, as now designed, has adequate capacity to withstand these temperatures."

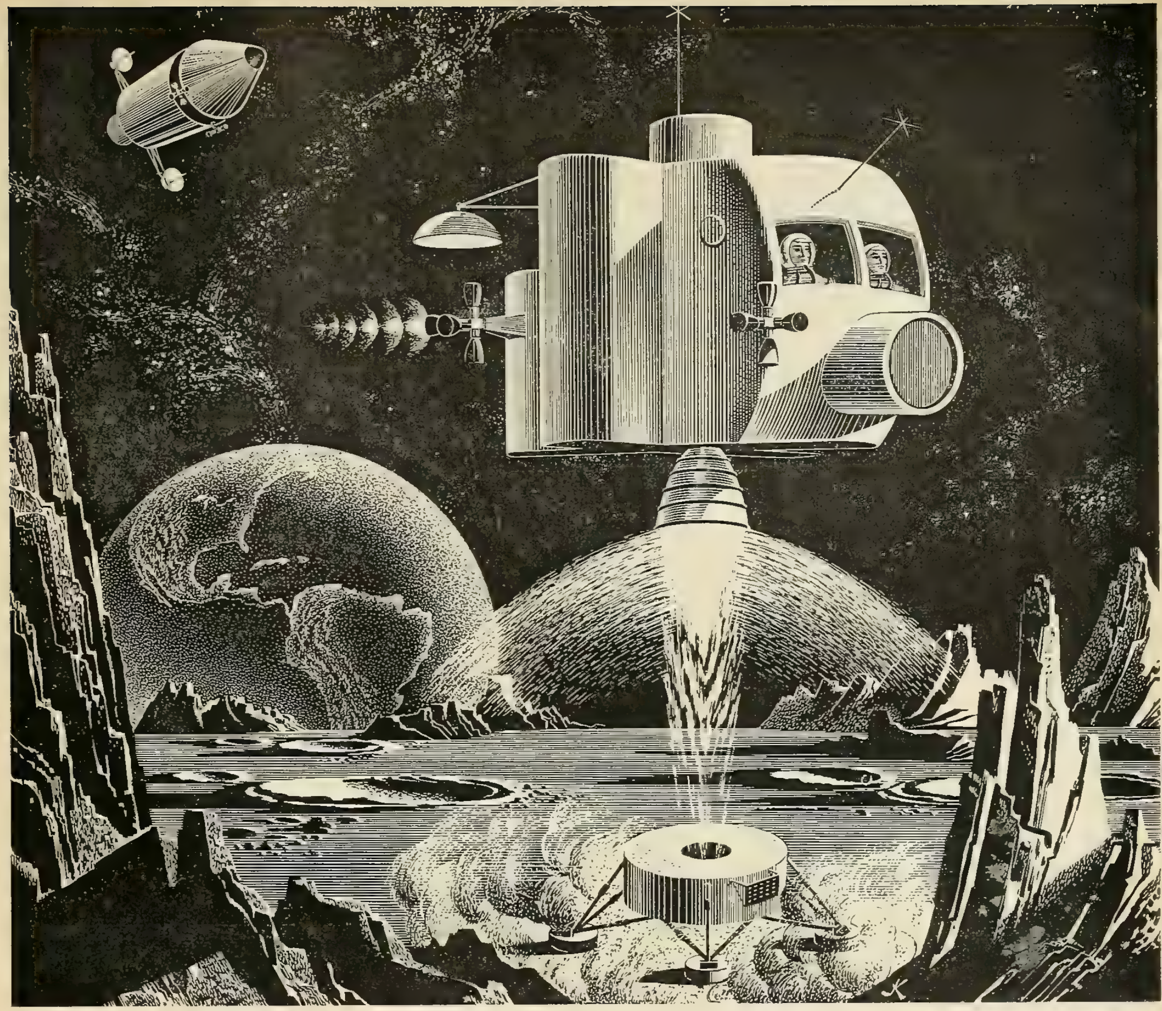
P&W officials said use of fluorine and additives in the oxidizer could increase the RL-10 thrust level from the present 15,000-lb. to the 30,000-lb. range if NASA has a requirement for such an engine.

But while some engineers are working to increase thrust, others in the same plant are devising means of reducing and controlling thrust to very low levels.

Preliminary work in this field has centered around controlling the flow of hydrogen through the turbine which powers pumps feeding hydrogen and oxygen to the engine.

This, accomplished by throttle valves in the lines, has reduced thrust to levels as low as 8% of rated thrust, and Richard J. Coar, engineering manager of the center, said the figure "is not necessarily the bottom."

He said principal application of the throttle-controlled engine will be in the areas of landing, docking or maneuvering satellites. ■



Engineering Opportunities on LEM at Marquardt

Marquardt's increasing capability in reaction control systems is evidenced by the company's appointment by Grumman Aircraft Engineering Corporation to provide the critically important reaction control propellant system and thrust chamber cluster assemblies for the National Aeronautics and Space Administration's Apollo Lunar Excursion Module. LEM—the first U. S. vehicle that will operate exclusively in space—has created a number of exceptional career opportunities for engineers.

Other programs recently awarded to Marquardt include: the reaction control engines for the Project Apollo Service Module; the ullage rocket engines for the Saturn IV B; and the reaction control system for Syncom II.

These expanding programs, coupled with continuing company-sponsored research and state-of-the-art contracts, are responsible for the new assignments now open at Marquardt. A limited number of ground-floor opportunities presently exist for experienced engineers and scientists who want to join a dynamic company, well diversified in reaction control systems, electronics, airbreathing propulsion, and aerospace research.

If you hold an engineering degree, and possess a background in rocket motors and control systems, airbreathing propulsion, mechanical controls, propulsion cycle analysis, aerodynamic development, test instrumentation, or test operations, you are invited to send your resume, in confidence, to Mr. Floyd Hargiss, Manager, Professional Personnel, at the address shown below.

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THE Marquardt CORPORATION

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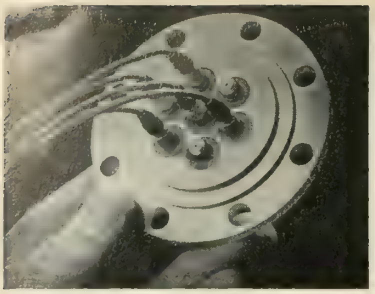

Hermetic Sealing

Complete in-plant capabilities for glass-to-metal sealing – from design through quantity production – are provided by Microdot's Hermetic Seal facility. Specializing in custom sealing, as well as hermetically sealed connectors and terminals, Microdot engineers will work with your engineering department and provide design solutions to your sealing problems. All Microdot hermetic seals receive rigid quality control and inspection, including final test by helium leak detector sensitive to 5 x 10-11 atm cc/sec.

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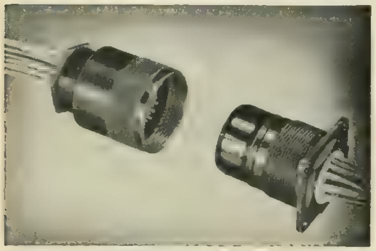

Microminiature Multi-Pin Connectors

Industry's most versatile, truly miniaturized connectors. Only ¼ size, ⅓ weight of current "miniature" types, Microdot Multi-pins contain up to 61 power or 19 coaxial contacts in a 1⅛" shell, are also available in shell sizes down to ¾". Standard line offers many options: interchangeable inserts for straight power, straight coax or combination power-coax layouts; choice of mounts and finishes; quick disconnect or screw-type couplings; assembled with specified Microdot cable or in kit form for bench/field assembly. Hermetically sealed connectors available on special order.

MICRODOT INC.

220 Pasadena Avenue
South Pasadena, California
Overseas: MICRODOT AG, Zug, Switz.

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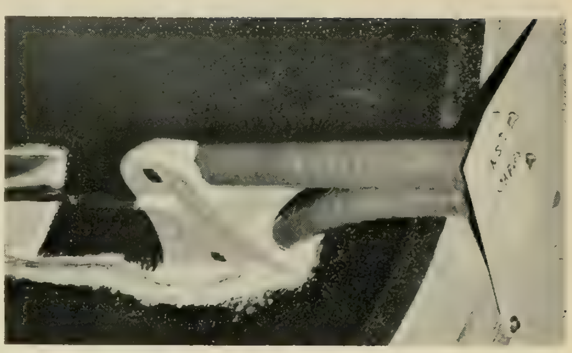


PROPELLANT WEDGES with triaxial accelerometers installed are bonded to the case wall of a Minuteman first stage engine. Tubing protects instrumentation wires during propellant loading.

Thiokol Monitors Propellant Behavior

DATA FROM instrumentation imbedded in the live propellant of a *Minuteman* first stage motor are being used to verify hundreds of previous dynamic checks on propellant behavior during transportation and handling.

Thiokol Chemical Corp. engineers cast accelerometers into a full-scale *Minuteman* motor and then subjected the rocket to industry's largest force-vibration complex.

The results will permit Thiokol to verify its analytical studies of propellant characteristics in dynamic situations—adding another factor to the reliability assurance program in effect at the firm's Wasatch Div.

Accelerometers were cast in the motor after an extensive engineering study determined the necessary number and location of the devices. Thiokol engineers selected triaxial piezo-electric accelerometers from Gulton Industries, Inc., since they best met the dynamic response, safety, density and temperature requirements.

Twenty-four accelerometers were used—14 imbedded in the propellant and 10 mounted on the propellant surface. The devices and cable assemblies were first cast in propellant wedges which were bonded to the case wall. The case was then loaded with propellant in the normal fashion.

After curing, the motor was X-rayed to verify the accelerometer positions and check for cracks and voids in the grain.

Prior to actually imbedding the accelerometers in the full-scale motor, a 7-ft. segment of the motor was loaded with propellant and instruments. One end of the segment was removed to allow visual inspection of the propellant response to imposed stresses.

- **Solid shaker**—The huge force-vibration facility is equipped to perform three specific types of testing.

—Resonance search testing to determine the natural vibration frequencies, mode shapes and acceleration amplifications.

—Response testing to verify mathematical analysis, to determine linear response at different frequencies, and acceleration of "g" levels, and to pinpoint stress relationships at each response level.

—High load fatigue testing to verify predicted failure or potential failure areas previously analyzed.

The installation consists of electro-hydraulic and electrodynamic exciter systems together with the necessary control and data acquisition systems. The electrohydraulic system includes two pairs of actuators.

One system has a force output of 60,000 lbs., a velocity of 10 in./sec., a frequency of 25 cps and a double amplitude displacement of 5 in. The second system reaches a force output of 200,000 lbs., a velocity of 36 in./sec., a frequency of 400 cps and double amplitude displacement of 0.5 in.

Variable-volume pumps on the electrohydraulic units are parallel-system mounted, valved and arranged for individual flow, operation and control. Each pump has a separate reservoir.

- **Versatile control**—The system control console permits either manual or automatic operation. Exciter frequency, amplitude and phase are adjustable over a 0 to 3,000-cps range, full drive and 180 degrees, respectively.

The drive signal generator is an oscillator type with an accuracy of ±2% of the operating frequency, and a frequency drift of less than ±1%. Distortion is less than 0.5% over the specified frequency and amplitude range.

The exciter amplitude is independently and continuously adjustable from 0 to full drive. The amplitude of both exciters can be adjusted simultaneously. The two servosystems are designed to maintain pre-selected displacement, velocity, and acceleration levels while the frequency is automatically varied.

An automatic phase-control system maintains the pre-set relationship between the two actuators within ±3 degrees. A monitor panel equipped with an oscilloscope permits direct reading of displacement, velocity, and acceleration and frequency levels.

The facility has two electrodynamic exciter units—each with an output force of 30,000 lbs. Electronically phased together, total output is 60,000 force lbs.

The exciters have a velocity range up to 70 in./sec., a double amplitude displacement range up to 1 in. and a frequency range from 5 to 2000 cps.

- **Graphic display**—The data acquisition system can accept and process on 80 channels. Amplitude is recorded on all channels while phase and distortion are taken only from the accelerometer and strain gage channels and amplitude ratio only from the accelerometer channels.

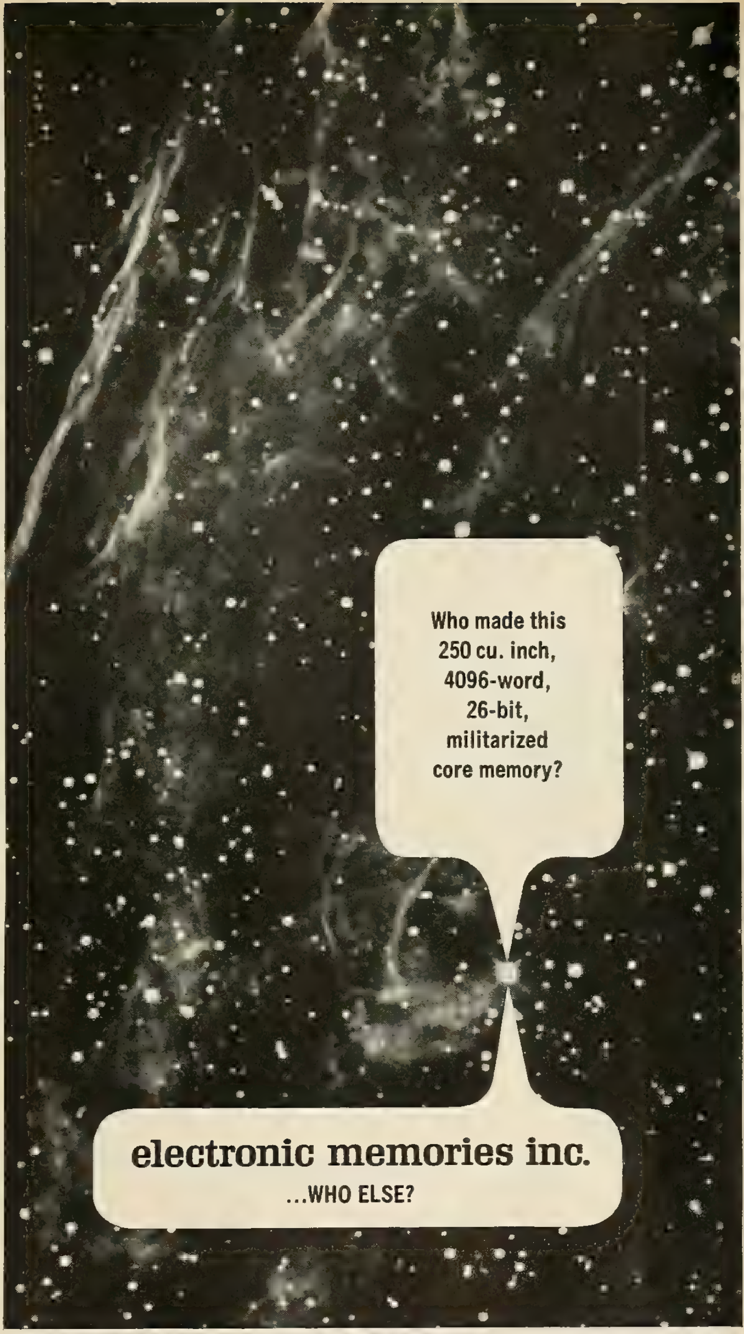
The data reduction system consists of a digital-analog computer which records the information from the test specimens. This data is provided in the form of X-Y plot and visual display.

The system automatically plots any desired ordinate parameter against one of the indicated abscissa parameters. The acceleration channels can be programmed to plot four ordinate parameters on a single record—or any combination of the four.

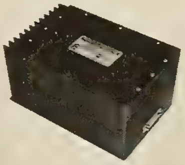
Strain data is plotted in a similar manner for the three ordinate parameters. Temperature is plotted in amplitude only. Each ordinate uses a distinctive symbol to clearly mark a particular plot on a multiplot record.

Tests are conducted in sweep and dwell modes. In the former, a specific frequency spectrum is covered in discrete steps. After the data is processed and stored—a 6-to-8-second process—shaker and data systems are reoriented.

The dwell mode is used to describe the contortions of the test specimen and to pinpoint resonance. All data is processed while the drive frequency and amplitude are held constant. Amplitude, phase distortion and ratio are accumulated and plotted against time, transducer location or frequency. ■



Electronic Memories' standardized core memories give economical random access militarized operation over a −55°C to +100°C range. These memories are available in two high density packaging versions: The pluggable version has modular, welded plug-in circuits for simplified maintenance in ground based and aerospace applications such as support and control systems for tactical weaponry. The other version has all sub-assemblies incorporated in welded modules for maximum package density and reliability. Both versions utilize standard components in special high density circuit designs to achieve maximum miniaturization without sacrifice of field proven reliability. May we send you a copy of our specifications brochure?



*REGISTERED

ELECTRONIC MEMORIES INC. 12621 Chadron Avenue, Hawthorne, California

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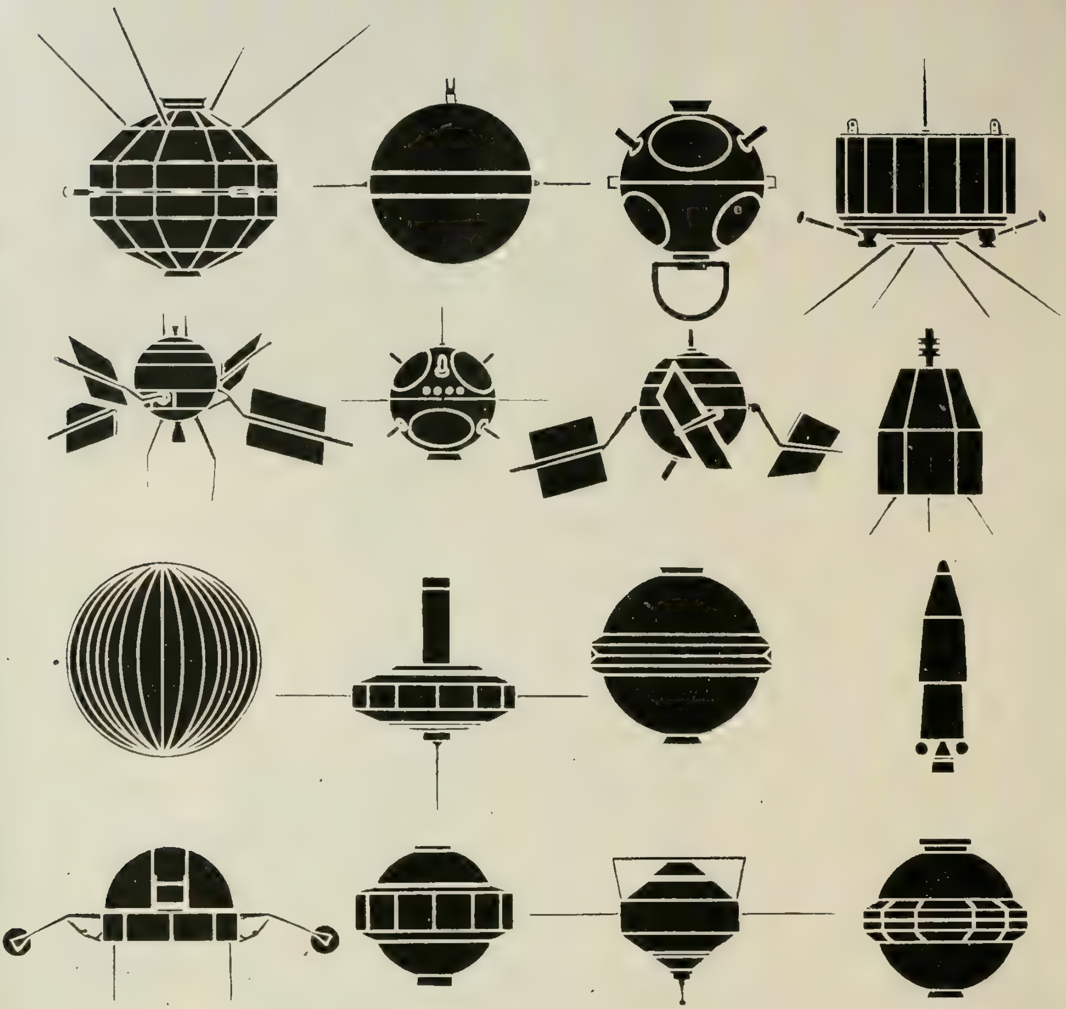

Colleagues!

(they all use Sonotone nickel-cadmium batteries)

These satellites have two things in common. They all have been successful. And they all have used Sonotone rechargeable sintered-plate, nickel-cadmium cells or batteries. Why Sonotone? Because they're reliable.

Just look at the box score of successfully-launched satellites with Sonotone:

Explorer VI
Explorer VII
Pioneer V
Tiros I
Transit I-B
Midas II
Transit II-A
Greb I
Echo I
Courier
Tiros II
Transit III-B
Lofti
Transit IV-A
Greb II
Tiros III
Transit IV-B
TRAAC
Tiros IV
OSO-1
Tiros V
Tiros VI
Alouette
Anna I-B
Relay
Transit V-A
Tiros VII
Next?

(Can you pick out the 16 illustrated above?)

Sonotone has a special Space Battery Laboratory which is constantly studying the high reliability and tough environmental standards vital to space equipment. One result is the new hermetic seal, which adds years of life to portable power in outer space.

What are you designing? Satellites or shavers, let Sonotone help you out, solving your portable power problems. Write today, stating your application requirements, and we'll get busy right away.

Sonotone Batteries
portable power for progress

Battery Div., Dept. B98-83, Sonotone Corp., Elmsford, N.Y. • Aircraft, Missile and Satellite Batteries • Power Supplies • Battery Chargers • Audio Products • Hearing Aids

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Mergers and Acquisitions

National Distillers and Chemical Corp. has purchased the H. W. Loud Machine Works, Inc., a maker of missile/space and aircraft equipment. National Distillers described the acquisition as an attempt to "further National's penetration of aerospace and defense areas." . . . *Weinschel Engineering Co., Inc., Gaithersburg, Md., has purchased rights to several product lines of General Communication Co., Boston, a subsidiary of Atlantic Research Corp. Included in the purchase are pulse power calibrator, portable radar test set, and pulse power generator.* . . . Babcock Electronics Corp., Costa Mesa, Calif., has acquired the electronics division of Traid Corp., Fullerton, Calif. Under Traid, the division developed an electronic system used to determine accuracy in missile target practice. . . . *The Matheson Co., Inc., East Rutherford, N.J., is purchasing the scientific division of the Harshaw Chemical Co., Cleveland, and the Chicago Apparatus Co. Matheson plans to establish a new subsidiary, to be called the Matheson Scientific Co.* . . . Datapulse, Inc., Inglewood, Calif., is purchasing all outstanding stock of the DeMornay-Bonardi Corp., Pasadena, for $500,000. DeMornay-Bonardi manufactures microwave components and test equipment.

Industry Facilities

Molectro Corp., Santa Clara, Calif., has completed laboratory and production facilities for development and manufacture of integrated circuits and other solid-state devices. The opening of the 20,000-sq.-ft. plant follows Molectro's recent consolidation with two other electronic corporations. . . . *Special Metals, Inc., New Hartford, N.Y., has expanded its operations by $1,750,000. A producer of vacuum melted alloys and superalloys, it has purchased a rolling mill and wire mill. Conversion was formerly contracted to outside facilities.* . . . The Philco Corp., Philadelphia, has announced that the facilities of its Lansdale Div., will be tripled over the next six months. The expansion will be concentrated in the area of microelectronic engineering and product development. . . . *Winston Research Corp., a subsidiary of Fairchild Camera and Instrument Corp., has moved into a new 20,000-sq.-ft. plant in Los Angeles. Winston manufactures wideband recording, transmitting and receiving systems for missile/space, aviation and industrial use.* . . . Computer Applications Inc., New York, has acquired the Electronic Business Services Corp., New York City, a data processing center. Computer Applications provides programming and analysis services to government and industry on advanced data processing systems and techniques.

Company Representatives

The Thorson Co., Los Angeles, has been named West Coast representative for Dynatech Corp., Cambridge, Mass. Thorson will sell the firm's thermophysical properties measurements instruments to the missile/space industry. . . . *Gaine Engineering, Detroit, and Willowick, Ohio, has been appointed sales representative for Waveline, Inc., Caldwell, N.J. Gaine will cover the Ohio, Michigan and western Pennsylvania area for Waveline, producer of microwave test equipment and waveguide assemblies.* . . . Gerber Scientific Instrument Co., Hartford, Conn., has established a new network of sales representatives to cover the U.S. and Canada. The sales network includes Applied Measurements, Concord, Mass.; the Gawler-Knoop Co., Roseland, N.J.; W. A. Brown and Associates, Fort Lauderdale, Fla.; the S. Sterling Co., Southfield, Mich.; Pivan Engineering, Chicago; the Mitchell Speairs Co., Fort Worth, Texas; the Brooks-Feeger Assoc., Denver; Ward Associates, Pasadena, Calif.; Showalter-Judd Inc., Seattle, and Electromechanical Products, Agincourt, Ontario, Canada. . . . *Admiral Corp. has opened a new Washington, D.C., office. Address is the Cafritz Building. Manager is Joseph S. Campbell, and Robert E. England is liaison engineer.* . . . The F. M. Sales Co., Denver, has been appointed representative of the Mica Corp., Culver City, Calif. F. M. will sell the line of Micaply laminates in the Colorado, Utah, Wyoming and Montana area. . . . *Industrial Circuits Co., East Paterson, N.J., has named three firms to cover sales in New England area and other northeastern states. The representatives include G. M. Hathaway Electronics, Inc., Cambridge, Mass.; A. L. Livera and Associates, Madison, N.J. and Mineola, N.Y.; and M. D. Enterprises, Hohokus, N.J.* . . . Tri-State Electronics, Inc., Cincinnati, and R. C. Carter and Associates, Van Nuys, Calif., have been appointed sales representatives for the New England Laminates Co., Inc. Tri-State will cover Ohio, Indiana, Kentucky, western Pennsylvania and Alabama. Carter will handle sales in southern California.

International

Beckman Instruments, Inc., has established marketing organizations in France and the Republic of South Africa. The Fullerton, Calif.-based electronics firm formed the French organization through acquisition of Promesur, formerly the Beckman dealer in that country. Beckman marketing in South Africa will be directed by a newly formed sales subsidiary, Beckman Instruments (Pty.) Ltd., with headquarters in Capetown.

Potpourri

The Navy's Bureau of Ships has released the first integrated circuit military specifications. Circuits involved are Diode-Transistor Logic (DTL) blocks consisting of logic gates, dual inverters, and memory diode clusters. The device specs describe circuits developed for the Navy by Univac Div. of Sperry Rand Corp. and produced by Motorola Semiconductor Products Div.

contracts and procurements

AWARDS

AIR FORCE

$2,000,000—**Sylvania Electric Products, Inc.**, Waltham, Mass., for work on a ground electronics system. Work to be performed at Waltham and in Buffalo, N.Y.

$650,000—**General Electric Co., Space Technology Center,** Valley Forge, Pa., for a study of problems in storing fuels in space.

$87,500—**Thiokol Chemical Corp., Alpha Div.,** Huntsville, Ala., for Model TX77-7 *Lance* rocket motors.

$77,875—**Avco Spaceflight Programs Office,** Tulsa, Okla., for study, design, fabrication and testing of instruments used in radiation measurements in a space environment.

$31,360—**Associated Piping and Engineering Co., Temp Flex Div.,** Compton, Calif., for elbow assemblies for use in *Atlas* missile.

$25,075—**Eberline Instrument Corp.,** Santa Fe, N.M., for digital memory and recorder.

Lockheed-California Co., Burbank, Calif., for a study to determine improved reliability standards in the design of spacecraft shell structures (undisclosed amount).

ARMY

$2,097,022—**Martin Construction Co.,** Merritt Island, Fla., for construction of a central telemetry building on Merritt Island for the manned lunar space program.

$1,100,000—**System Development Army Corp.,** Santa Monica, Calif., for service and materials to conduct a system training program for Army air defense systems.

$528,796—**H. J. High Construction Co.,** Orlando, Fla., for facilities in support of the *Dynasoar* program involving a two-story missile research lab building at Cape Canaveral.

$424,338—**Bendix Corp.,** Southfield Mich., for design, fabrication and testing of a microchannel array fabrication and processing system.

$350,000—**Radio Corp. of America, Defense Electronic Products Div.,** Moorestown, N.J., for a technical feasibility study of the Army air defense systems.

$159,000—**Signetics Corp.,** Sunnyvale, Calif., for development of a family of integrated circuits capable of operating in the 10-megacycle range.

$60,000—**Video Color Corp.,** Inglewood, Calif., for advanced design and fabrication of a CRT thintube and monitor.

$42,974—**Hercules Powder Co.,** Wilmington, Del., for development of a hybrid propellant system for aircraft personnel ejection.

NAVY

$2,300,000—**Raytheon Co., Microwave and Power Tube Div.,** for four different types of magnetron tubes to power search radars, airborne radars and radar altimeters (four contracts).

$1,000,000—**Missile Systems Corp.,** Los Angeles, Calif., for classified missile assemblies.

NASA

$934,400,000—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for initial development and production of *Apollo* spacecraft command and service modules.

$250,000—**International Business Machines Corp.,** Rockville, Md., for manned space flight computation support.

$125,000—**United ElectroDynamics, Inc.,** Pasadena, Calif., for design, development and manufacture of four flexible high speed mixed high-and-low level PCM systems for use at Edwards AFB, Calif., on the lunar landing simulator program.

$112,600—**American Machine & Foundry Co., Advanced Products Group,** Stamford, Conn., for fabrication of a hydraulic supply unit for the *Saturn* program.

$94,000—**Regent Jack Mfg. Co., Inc.,** Downey, Calif., for design, construction and test of nine 3.5-million-pound hydraulic test cylinders for use in load testing advanced *Saturn V* equipment.

$78,157—**Henry J. Kaiser Co., Kaiser Engineers Div.,** Oakland, Calif., for development of a master transportation plan for the manned lunar landing program.

$64,068—**Sperry Rand Corp.,** Great Neck, N.Y., for a study of the feasibility of projection display systems in spacecraft and integration of these displays with the conventional panel-mounted instruments.

$58,000—**Brush Beryllium Co.,** Cleveland, Ohio, for a study of variables affecting the strength and ductility relationship in beryllium.

$34,692—**Grumman Aircraft Engineering Co.,** Bethpage, N.Y., for a study of cosmic ray collisions in space.

$30,760—**Technitrol Engineering Corp.,** Philadelphia, for operation and maintenance of telemetry equipment.

Northrop Corp, Nortronics Div., Palos Verdes, Calif., for a study of aerodynamic attitude and dynamic pressure sensing techniques for application during launch of space vehicles (undisclosed amount).

AEC

C. F. Braun & Co., Alhambra, Calif., for provision of architect and engineering services in test cell design work covering new facility Cell E at the Nuclear Rocket Development Station, Nev., and also covers design of proposed modifications of Cell C (undisclosed amount).

INDUSTRY

$2,500,000—**Ampex Corp.,** Redwood City, Calif., from **Defense Electronics, Inc.,** for high performance instrumentation recorders to equip the Atlantic Missile Range.

$2,250,000—**Electric Storage Battery Co., Exide Industrial Div.,** Philadelphia, from the **Boeing Co.,** for emergency batteries for use in the *Minuteman* weapon system.

$1,300,000—**Radiation, Inc.,** Melbourne, Fla., from the **Boeing Co.,** for production of key parts of the PCM telemetry system used in the three-stage *Minuteman* missile.

$1,000,000—**United ElectroDynamics, Inc.,** Pasadena, Calif., from the **Boeing Co.,** for FM and digital instrumentation equipment for the *Minuteman* programs.

$786,000—**T. D. Little Electric Co.,** Montgomery, Ala., from **Aerojet-General Corp.,** for instrument and control installation at NASA's Huntsville, Ala., testing facility.

$750,000—**United ElectroDynamics, Inc.,** Pasadena, Calif., from **Fairchild-Stratos Corp.,** for supplying signal conditioning dc amplifiers for use in telecommunications equipment on board the *Apollo* spacecraft.

$500,000—**Packard Bell's Computer Div.,** Los Angeles, from **North American Aviation, Inc.,** for an expanded version of the Trice computing system.

$494,000—**Cameron Iron Works,** Houston, Tex., from **Aerojet-General Corp.,** for titanium alloy forgings.

$464,000—**American Potash and Chemical Corp.,** Henderson, Nev., from **Aerojet-General Corp.,** for ammonium perchlorate.

$350,000—**Space Corp.,** Garland, Tex., from the **Boeing Co.,** for the manufacture of support vans for the *Minuteman* missile program.

$335,000—**Swedlow, Inc.,** Los Angeles, from **Aerojet-General Corp.** and **Straza Industries,** for an undisclosed number of reinforced plastic exit cones for the *Minuteman ICBM,* Wing II.

$150,000—**Cubic Corp., Temec Inc.,** San Diego, from **Sandia Corp.,** for 17 antenna pedestals.

$10,500—**Sperry Rand Corp., UNIVAC Div.,** New York City, from **Communications Satellite Corp.,** for computer services in connection with global satellite communication systems studies.

Meehleis Steel Co., Los Angeles, from **C. H. Leavell and Co.,** and **Peter Kiewit Sons Co.,** for installation of approximately 2,800 tons of reinforcing steel for the new *Titan III* missile launching Air Force project at Cape Canaveral (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Servicing of government-owned electronic equipment used for the measurement of research data in ground facilities, aircraft and missile instrumentation payloads consisting of, but not limited to, general categories such as electrical, electronic, optical, pressure, vacuum, mechanical, automatic control and indicating and recording instrumentation. Contractor shall provide service area within seven airline mile radius of Gate No. 4, West Area, Langley Station, Hampton, Va. a total of fourteen or thirty-six people depending upon availability of funds and certain test equipment as set forth in detail in NASA Spec L-3141. Bids are requested on a per hour basis. Job—IFB L-3141.

Bureau of Naval Weapons
Washington 25, D.C.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Raytheon Co., Sudbury, Mass., to provide engineering industrial support to MIT in the design and development of *Polaris* MK 2 guidance electronics assembly. This effort is a continuation of work previously undertaken by the above firm under an existing contract. PR-SP-1417-64. BuWeps Synopsis No. 56-64.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Ford Instrument Co., Long Island City, N.Y., to improve a pointing and firing cutout device for guided missile launching systems. Award will be made on the basis of a continuation of an R&D effort previously undertaken by the above firm. PR-SP-1415-64. BuWeps Synopsis No. 57-64.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Develop and obtain 130-140 MC tracking receiver. Unit has special characteristics which will make it suitable for experimental laboratory work in real-time tracking. Equipment will be installed and checked out at the Goddard Space Flight Center. One unit. RFP PCN 46868. RFP due date 9-9-63. A performance specification is available. Requests for copies of the RFP should be directed to the Goddard Space Flight Center, T&DS Negotiation Branch, Section B, Code 248, LSH, Greenbelt, Md. Inquiries may be made to Lawrence S. Harvey, Phone: 301-982-5725.

Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Avco Corp., Ordnance Div., Richmond, Ind., to provide MK 2 Mod O arming and fuzing devices and FAF battery MK 87 Mod O. Delivery requirements are such that it is necessary to procure this equipment from the original source who has the necessary production equipment set up to meet the urgent requirements. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting should contact the above firm direct referencing PR No. SP 1425-64, BuWeps Synopsis No. 70-64.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

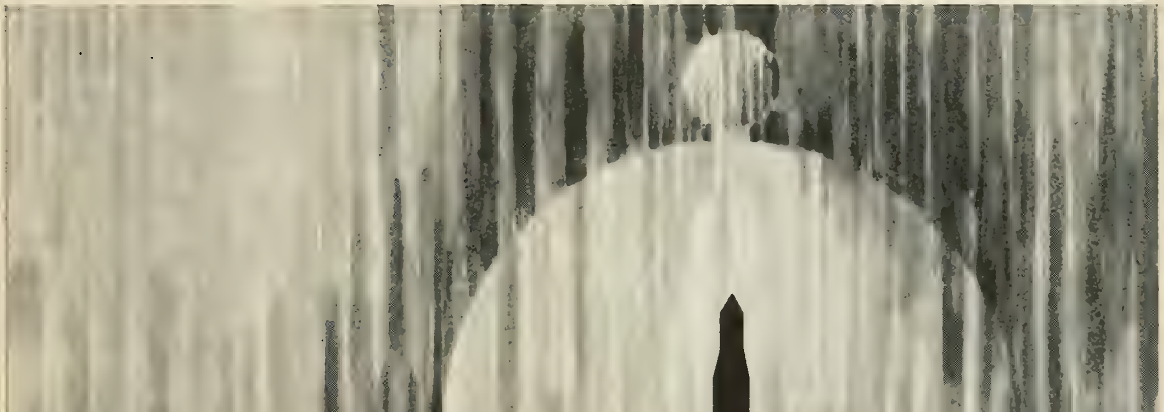
Semi-automatic digital pressure transducer calibration system for use in calibration of flight pressure transducers for *Apollo* research and development instrumentation program and future programs. Deliver to the Manned Spacecraft Center, Houston 1, Tex. RFP MSC-64-816P. RFP due date 9-5-63.

Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to General Electric Co., Missiles & Space Div., 3198 Chestnut St., Philadelphia, Pa., for preparation of a guide manual for a mechanized reliability data accumulation measurement and demonstration program for *Polaris.* The proposed contractor possesses the necessary background information and experience gained in similar efforts for other major defense programs to furnish the manuals in the time required. This notice is made for information purposes only. PR No. SP 1414-64. BuWeps Synopsis No. 71-64.

LOW TORR PARADOX
...AND HOW DOUGLAS DISCOVERED IT

"It ain't necessarily so." This could be the theme song of Douglas research, where they take nothing for granted... not even previous research. ☐ This Doubting Thomas attitude has resulted in discovering a paradox relating to the deterioration of metals in the low torr (hard vacuum) environment of cislunar space. ☐ Previous short period vacuum chamber tests had indicated that the lack of corrosion by air molecules in such an environment would slow the rate of metal fatigue. But Douglas scientists were skeptical and decided to do deeper research over a longer period. Results of these more thorough experiments indicate that metal fracture in outer space may actually occur at stress levels equal to or below those in earth-atmosphere environment. In view of these findings, scientists are now re-examining their earlier concepts of structural requirements for space vehicles.



Careful research like the above in 23 broad technological areas is now under way at Douglas. Major Douglas divisions are located in Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

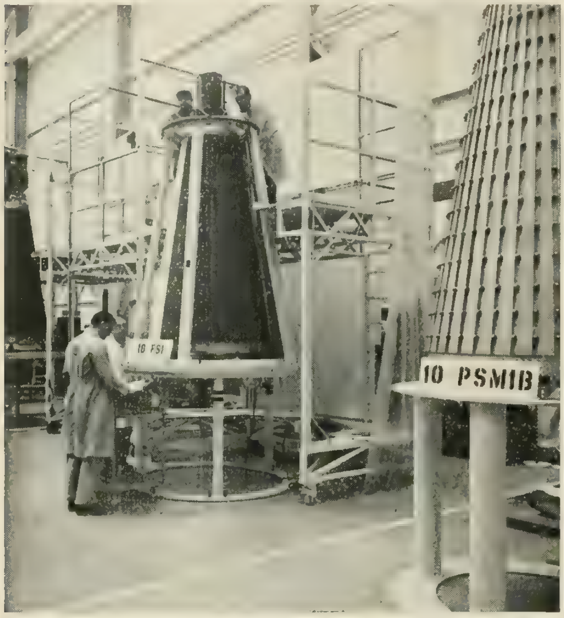
DOUGLAS

CHALLENGE IN SPACE

FOR SENIOR TECHNICAL SPECIALISTS:

Compact Nuclear Systems to Power Tomorrow's Spaceways

Life support equipment, navigation instrumentation, experimental devices, all things electrical for man's future space flights can bear the imprint of your talent through advanced nuclear work at Atomics International. If you have 5 to 7 years of aerospace hardware experience, an EE, Physics or ME degree, the challenge of nuclear auxiliary power for space lies squarely before you. Join A.I. now in this vitally important work.



Fabrication of SNAP 10A systems at A.I.

Atomics International is a prime contractor for SNAP nuclear reactor systems for the U.S. Atomic Energy Commission. Responsibilities of the company include the entire SNAP 10A and SNAP 2 systems, as well as the reactor for SNAP 8. These power sources are designed to generate from 500 to 35,000 watts of electricity for a one-year period of unattended operation in space. Already several A.I. SNAP reactors have successfully passed their initial ground operating tests.

For the National Aeronautics and Space Administration, A.I. is studying the uses of compact nuclear power sources on the moon. To be determined: what design modifications would fit SNAP 2 and SNAP 10A for powering instruments and communications equipment on the lunar surface? Also, how could SNAP 8 be adapted to the power needs of a manned lunar base? SNAP applications might include lunar communications stations capable of operating for long periods unattended... perhaps a manned lunar experimental laboratory or astronomical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

SYSTEMS & CONTROL ANALYSIS — Analysis and simulation of complete nuclear power plants to develop reliable, automatic control and instrument systems to analyze reactor kinetics, dynamics, stability, thermal characteristics and reliability.

STRESS ANALYSIS — Provide stress analysis of compact nuclear power plants for space applications including review of all designs with respect to stresses resulting from thermogradients; transients, static loadings, vibrational and shock loadings.

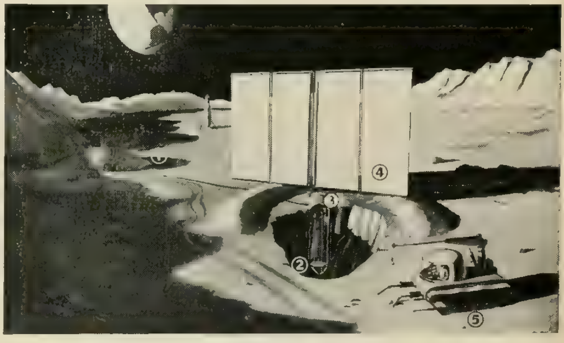
COMPONENT TESTING — Analysis of liquid metal heat transfer components in the SNAP 2/10A systems. Calculations involve knowledge of fluid flow, heat transfer, stress analysis and basic electrical engineering.

ENVIRONMENTAL TESTING — Plan and provide instrumentation for environmental tests of SNAP components and systems primarily for shock, vibration, acceleration, static loading and acoustics.

STRUCTURES — Analyze, investigate and physically test SNAP 2 radiator condensers and test fixtures to determine structural characteristics for launch loads, aerodynamic heating, shock and vibration.

DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. H. Newton
Personnel Office, Atomics International
8900 De Soto Ave.
Canoga Park, California

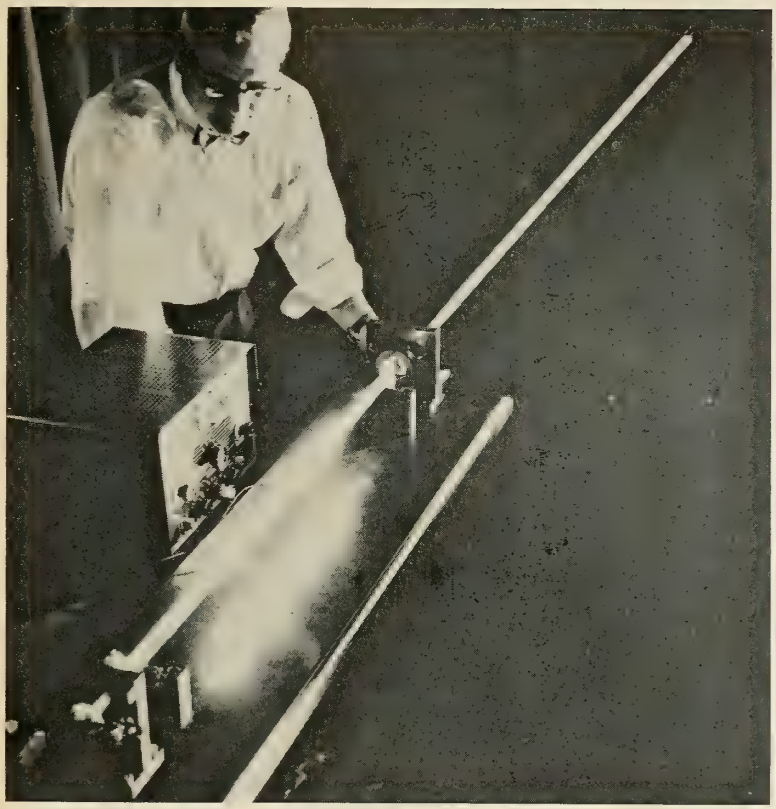


Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL

DIVISION OF NORTH AMERICAN AVIATION



New Product of the Week:

Gallium-Arsenide Injection Laser

RCA has developed a gallium-arsenide injection laser capable of producing laser action directly from an electrical signal. The RCA Dev. Type TA-2440 provides emission wavelength of 8,400 Å. Other typical values of the unit at 77°K are: 20 amp. threshold current; 8-Å line width at threshold; 10^{-3}-cm junction area; and 0.5-watt laser radiation power.

Also available is a cuprous chloride light modulator making possible low-power, high-frequency modulation of laser beams.

Circle No. 225 on Subscriber Service Card

S-Band TWT Amplifier

The Instruments/Subsystems Div. of Huggins Laboratories, Inc., has developed a packaged continuous-wave S-band traveling-wave tube amplifier.

Over the 2.0- to 4.0-gc frequency range, this amplifier exhibits the following minimum RF performance: 35-db small-signal gain, 1-watt saturation power output, 30-db maximum noise figure. Spurious modulation is at least 35 db below signal.

The unit has a front-panel grid modulation jack. AM bandpass is dc to 100 kc, and a minimum change in RF output of 20 db is obtained with a grid voltage of 30v.

Circle No. 226 on Subscriber Service Card

Continuous Wave Gas Laser

The Microwave Device Div. of Sylvania Electric Products Inc. has developed a self-contained, sealed-off, CW (continuous wave output) gas laser.

Designated GL-6211, it features an all-quartz, sealed-off laser tube with Brewster angle windows and external

ENGINEERS • SCIENTISTS

PAN AM

COMMAND CONTROL

At The Atlantic Missile Range

Multiple countdowns, command coverage of the booster over its entire burn period, orbital transfer control—the design of systems for these projects are just some of the command control assignments for engineers with Pan Am's Guided Missiles Range Division.

To achieve these goals, our engineers are: designing a redundant, van-mounted, fast-reaction command station • developing UHF antenna systems, either slaved to a target acquisition system or steered by remote control • planning and implementing new sites with UHF/SHF command control instrumentation • developing a new digital command and coding system to provide secure transmission of data with a high information rate capability... as well as implementing a system to automate the entire instrumentation and status reporting system at AMR.

Current openings require BSEE or equivalent and a minimum of 3 years systems experience in UHF/SHF propagation and data transmission or in equipment design for guided missiles control systems. Applicants should have a working knowledge of digital transmission techniques and FM modulation.

Write in confidence to: Manager, Range Development, Dept. 56H-4

PAN AM
GUIDED MISSILES
RANGE DIVISION
PAN AMERICAN WORLD AIRWAYS, INC.
P. O. BOX 4465, PATRICK AIR FORCE BASE, FLORIDA
AN EQUAL OPPORTUNITY EMPLOYER

Circle No. 23 on Subscriber Service Card

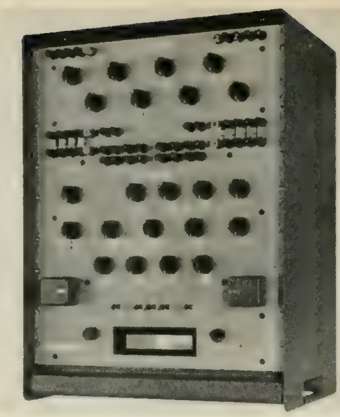
optical system. Its operation does not require a vacuum station or gas filling equipment.

The GL-6211 operates in the following manner. The tube is filled with a gas mixture of helium and neon at a low pressure. A radio frequency field excites the atoms in the tube. Photons, or light, spontaneously emitted by some of the excited atoms, are reflected back into the excited gas mixture from 99% reflecting mirrors placed adjacent to both ends of the tube. These reflected photons stimulate neon atoms in the proper excited state which then emit additional photons precisely in phase with the stimulating photons.

Circle No. 227 on Subscriber Service Card

ESI Measuring Systems

A direct-reading double-ratio resistance comparison system is available from Electro Scientific Industries, Inc. The Model 121 is a matched assembly of a resistance bridge, special generator-detector and a lead corrector. It features a resolution of 1/10 ppm, circuits designed to eliminate lead and contact resistance and a comparison accuracy which approaches the NBS Wenner bridge (1 ppm over a range of ± 6000 ppm). Certified corrections can be set on separate dials before making measurements, providing direct reading of the measured value without additional calculations.



Circle No. 228 on Subscriber Service Card

Surface Temperature Transducers

Ultra thin surface sensing temperature transducers that withstand temperatures from —435° to 800° F with an accuracy of ±0.01° C are available from Thermal Systems, Inc.

The developed platinum wire unit is constructed in a method that permits the maximum response of surface temperature. Any size, resistance value, or calibration requirement can be supplied.

Circle No. 229 on Subscriber Service Card

Double Pulse Generator

Single pulses to 3 mc, double pulses to 800 kc, and outputs of 50v into 50 ohms with 10 nanosecond rise times are featured in the Model 102-S3 Double Pulse Generator developed by Datapulse, Inc.

The 102-S3 generates a variable separation main pulse pair in each cycle, making it ideal for resolving time studies, flip-flop and logic circuit design and beacon simulation.

Single or double pulse operation is selectable by a panel toggle switch. In the single pulse mode, operation is identical to the standard Datapulse Model 102 Pulse Generator. In the double pulse mode, the first pulse in each pair occurs at a fixed delay of approximately 0.15 μsec from the Sync Output. The second pulse in each pair is variable delayed from the Sync Output, limited by (1) a min. delay of approximately 0.9 μs (2) a min. separation between pulses of 0.5 μsec and (3) a max. delay of 70% of the Sync

---

GREATER POWER in smaller packages for greater missions into space

Thanks to Lockheed Propulsion's Nitroplastisol formulations—which surpass all others in the rocket propellant industry because they combine in a single system these four essential attributes:

1) Safety in manufacture and use. 2) Proved high performance. 3) Simplified processing. 4) Excellent storability.

An extra-performance nitrocellulose base composite propellant capable of use over the entire range of environmental conditions now required of rocket motors, it is in current use in such programs as: The Army's Mauler, ground to air missile; upper stages for classified space missions; as well as the recently-committed contract whereby LPC participates in propellant development for the Sprint missile—a part of the Nike-X anti-missile system.

With the development of Nitroplastisol (along with other major propellant systems) Lockheed Propulsion has now assumed a strongly competitive position in solid propellant technology. Constant experimentation with unusual ingredients is carried on in Company-funded research programs as well as under government sponsorship. Research for improving production propellants goes on 'round the clock.

As a result, these and other wide-ranging programs in high-energy formulations offer scientists and engineers genuine opportunity for growth

LOCKHEED PROPULSIO

Output period. Both pulses in the pair are simultaneously controlled in amplitude, polarity, duration, and rise time.

Circle No. 230 on Subscriber Service Card

Interconnection System Packages

Interconnection/system packages are available from the Amphenol Connector Div. of Amphenol-Borg Electronics Corp.

Samples include modular interconnecting devices and motherboards made up of Amphenol strip connectors and Intercon pre-fabricated circuitry.

The program makes interconnection packages or systems available for electronic circuitry in missiles and computers.

Circle No. 231 on Subscriber Service Card

Half-Size Latching Relay

A half-size crystal-case magnetic latching relay is available from Filtors, Inc.

The unit is two-coil and is sealed with an electron-beam welder which welds without contaminating flux in a near perfect vacuum. The all-welded relay also conforms to the requirements of MIL-R-5757D.

Specifications: temperature range is —65° to 125° C; dielectric strength is 1,000 volts rms, 500 volts rms between contacts; insulation resistance: 1,000 megohms, minimum; contact arrangements: 1 or 2 pole, double throw; contact resistance (max.): 0.05 ohm initial, 0.10 ohm after rated life; vibration: 30 g's from 5 to 3,000 cps; shock: 150 g's for 11 milliseconds.

Circle No. 232 on Subscriber Service Card

Ammonia Dissociator

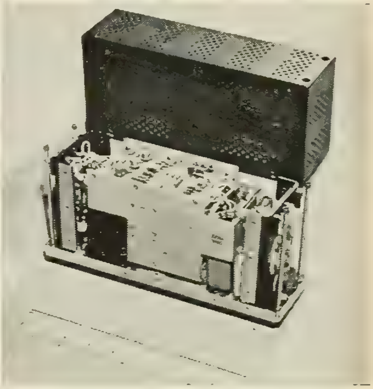
A pilot-model ammonia dissociator is available from Horton, Church & Goff, Inc.

Producing high-purity, low-dew-point atmospheres of 75% hydrogen and 25% nitrogen at the rate of 20 SCFH, the model (AD20) provides semi-conductor manufacturers with a low-cost, experimental means of comparing the relative merits and costs of dissociated ammonia and hydrogen in alloying, soldering and brazing processes.

Circle No. 233 on Subscriber Service Card

Static Inverter

A modular 250 va static inverter is being marketed by Varo, Inc. The single phase, 115-v 400-cps sine wave inverter is designed for military airborne applications. The inverter may be operated into a varying power factor load.



Other features of the all-silicon semiconductor inverter include provi-

and development. LPC is a young, fast-growing company now in position to provide even more in the way of ground-floor openings.

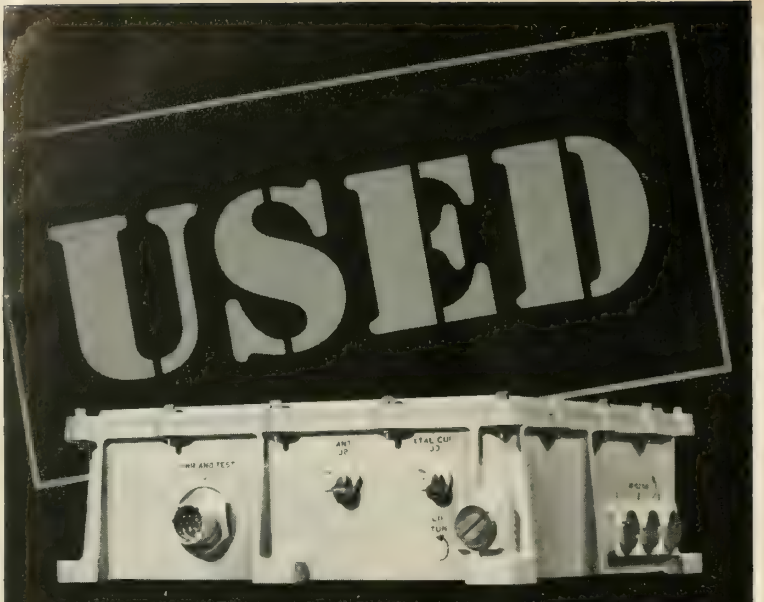
SCIENTISTS AND ENGINEERS: Our most productive years are ahead of us. So are yours. We invite you to investigate LPC openings in: Analytical Engineering; Visco-elasticity; Proposal Engineering; Project Engineering; Tactical Weapons Engineering; Propellant Development; Physical or Inorganic Chemistry; Chemical Engineering; Thermodynamics; Aerodynamics; Instrumentation and Test Engineering; Reliability; Advanced Systems Analysis.

Write: Professional Employment Office, Dept. 5208, P. O. Box 111, Redlands, California. An Equal Opportunity Employer.

P. S.—A word to the wives (husbands, too). Living is mighty pleasant in Redlands. This smog-free, friendly community, with fine schools and universities, shopping centers, etc. is only a 70-minute drive from Los Angeles; and with quick access to famed Southern California mountain, desert and beach resort areas.

OMPANY **REDLANDS, CALIFORNIA**

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION



TRANSPONDERS

PROVEN RELIABILITY IN ACTUAL USE makes Motorola radar transponders the logical choice for critical tracking, data and control missions. Case in point... AN/DPN-66 (Motorola SST-102A) illustrated above, **USED ON SATURN, PERSHING** and over 15 other current aerospace programs. A precision C-band unit, weighs 10.8 lbs., occupies 200 cu. in., it is just one of a complete line of transponders ready for fast, off-the-shelf delivery. Others include: **USED ON SCOUT, ATHENA** and at **WSMR** SST-131, this transponder is an extremely rugged microminiature superheterodyne unit, weighs only 3 lbs. and occupies just 40 cu. in., qualified for high-thrust, solid propellant boosters. Power: 400 watts. Sensitivity: —65 dbm. **USED AT AFMTC** AN/DPN-71, a high-power, superheterodyne unit for deep-space tracking assignments. Power: 20 kw. Sensitivity: —75 dbm. **USED ON SATURN,** and **PERSHING** AN/DRN-11, UDOP (UHF Doppler) transponder provides extreme range and position accuracy for ballistic vehicles. Power: 3 watts (15-watt power amplifier optional). Sensitivity: 5 microvolts. **USED ON NAVY AIRCRAFT** AN/APN-132, an X-band transponder with 5 channel decoder. Power: 100 watts. Sensitivity: —65 dbm. For full performance specifications, or modification data to meet other parameters, write our Instrumentation Products Group.

MOTOROLA **Military Electronics Division**
8201 East McDowell Road, Scottsdale, Arizona

Circle No. 24 on Subscriber Service Card

sions for remote turn-on and turn-off, short-circuit protection, and convection cooling.

Circle No. 234 on Subscriber Service Card

Automatic Switching-Time Test

The Industrial Products Group of Texas Instruments, Inc., has developed an automatic transistor switching-time test system. The equipment measures and records switching time from 1 nanosecond to 10 microseconds; all six standard switching-time parameters may be measured in performance circuits matched to user requirements.

The tests are made with a set of modules attached to TI's TACT (Transistor And Component Tester) system. Existing TACT testers can be quickly retrofitted with a modification kit. Digital control techniques via punched-card programming—a basic TACT design feature—provide the same absolute repeatability inherent in all TACT testing. Various tests may be intermixed in a test sequence in any random order. All tests—switching time, duty-cycle pulse, ac low or high frequency, or dc—are programmed into and handled by the TACT system in a similar manner.

Circle No. 235 on Subscriber Service Card

Microwave Sweep Signal Generator

A series of electronically swept signal generators is available from Alfred Electronics.

The 630A Series provides in one transistorized instrument precise frequency tuning plus known absolute power output of 10 dbm leveled to better than ± ½ db at rated output over each range. The 630A Series is available in 5 ranges: 1-2, 2-4, 4-8, 8-12.4 and 12.4-18 gc. Frequency is continuously adjustable over the entire range of each instrument.

Specifications are: RF power: at least 10.0 mw. Residual FM: less than

0.001% of peak of highest frequency. Drift: ± 0.01% per hour. Sweep Width: continuously adjustable from 0 to any part of the entire frequency range. Symmetrical Sweep: 0 to ±5% of range about any center frequency. Sweep Timing: 100 to 0.01 second.

Circle No. 236 on Subscriber Service Card

Slow-Speed Sweep Driver

A Slow-Speed Sweep Driver, Model SD-8A, has been developed by Jerrold Electronics Corp. It is an accessory to Jerrold's Sweep Signal Generators, Models 900-A and 900-B.

The Model SD-8A permits sweep rates as slow as 1 per 2½ minutes up to 15 per second, especially useful in x-y recording work.

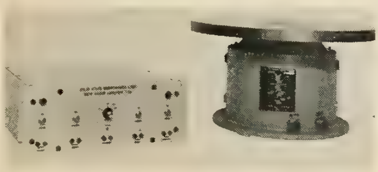
The slow-speed driver features: sweep repetition rates continuously variable over 4 switchable ranges; choice of automatic or manual sweep; forward, reverse, or no blanking; and metered output.

Power required: 115/230 vac, 50/60 cps, 100 watts.

Circle No. 237 on Subscriber Service Card

Precision Rate Table System

Developed by the Solid State Instrument Corp., the Model 712A Precision Rate Table System, intended primarily for testing rate gyros, is a direct drive servo controlled rate table incorporating an Inland Motor precision d.c. Tachometer and d.c. Torque Motor. All solid state circuitry is used in the servo electronics. The system covers a speed range up to 1500°/sec with wow and flutter of less than 0.1% at 0.1°/sec. This system also features a direct reading calibrated speed adjustment with an accuracy of 0.1%. A capsule slip ring assembly is included for 30 low noise shielded slip rings.



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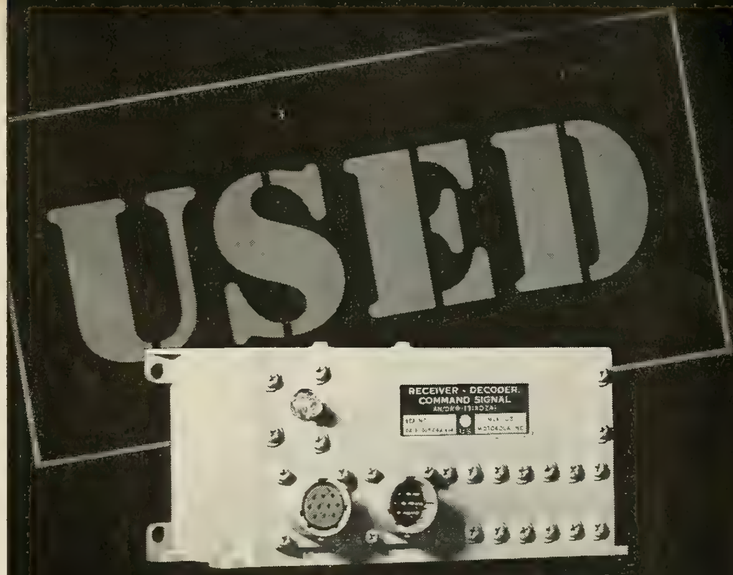
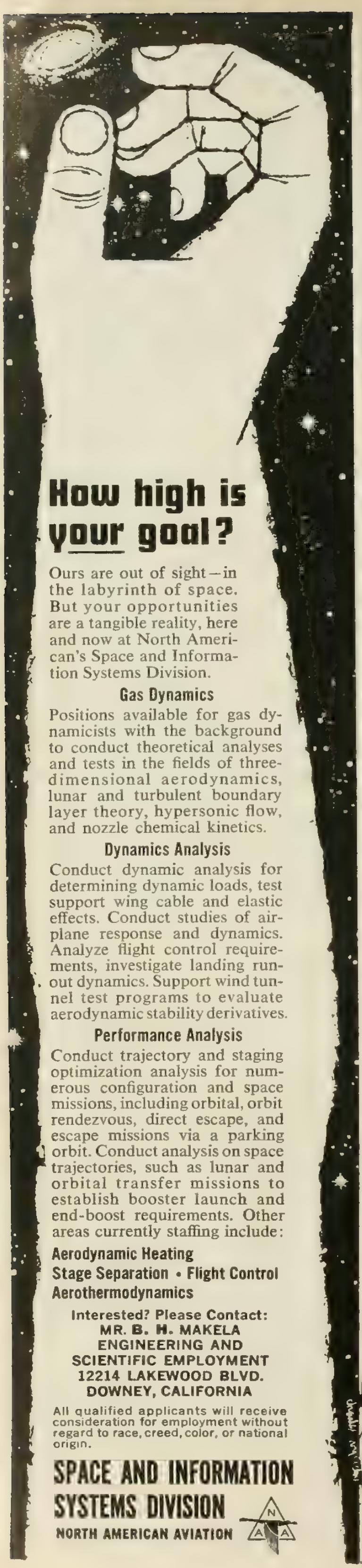


COMMAND RECEIVERS

PROVEN RELIABILITY IN ACTUAL USE has made Motorola command receivers the most widely specified command instrumentation today for advanced aerospace functions. These compact FM receivers deliver a threshold sensitivity of 5 microvolts over a full temperature range of —54° C to +71° C, and have been fully qualified to other extreme environmental requirements of the most rigorous missile and space applications. They can also be supplied with a complete selection of tone channels from 0 to 20. For example... **USED ON SATURN,** Motorola Model MCR-101, shown in illustration above, provides 10 channels, weighs only 2 lbs., 15 oz. **USED ON AGENA** MCR-307, the smallest, lightest 3-channel unit made, weighs but 2 lbs. **USED ON POLARIS** MCR-312, features an isolated ground system, supplies 3 decoder channels, weighs 3 lbs. **USED ON MINUTEMAN** MCR-403, contains 4 decoder channels, weighs 3 lbs., 13 oz. **USED ON MERCURY** MCR-102/MAD-101, receiver-decoder combination, provides a 20 channel system, weighs but 5 lbs. Standard 3- and 10-channel receivers are available for fast, off-the-shelf delivery. For full performance specifications, or modification data to meet other parameters, write our Instrumentation Products Group today.

MOTOROLA **Military Electronics Division**
8201 East McDowell Road, Scottsdale, Arizona

Circle No. 29 on Subscriber Service Card



How high is your goal?

Ours are out of sight—in the labyrinth of space. But your opportunities are a tangible reality, here and now at North American's Space and Information Systems Division.

Gas Dynamics

Positions available for gas dynamicists with the background to conduct theoretical analyses and tests in the fields of three-dimensional aerodynamics, lunar and turbulent boundary layer theory, hypersonic flow, and nozzle chemical kinetics.

Dynamics Analysis

Conduct dynamic analysis for determining dynamic loads, test support wing cable and elastic effects. Conduct studies of airplane response and dynamics. Analyze flight control requirements, investigate landing runout dynamics. Support wind tunnel test programs to evaluate aerodynamic stability derivatives.

Performance Analysis

Conduct trajectory and staging optimization analysis for numerous configuration and space missions, including orbital, orbit rendezvous, direct escape, and escape missions via a parking orbit. Conduct analysis on space trajectories, such as lunar and orbital transfer missions to establish booster launch and end-boost requirements. Other areas currently staffing include:

Aerodynamic Heating
Stage Separation • Flight Control
Aerothermodynamics

Interested? Please Contact:
MR. B. H. MAKELA
ENGINEERING AND
SCIENTIFIC EMPLOYMENT
12214 LAKEWOOD BLVD.
DOWNEY, CALIFORNIA

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

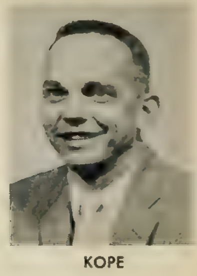
SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

names in the news

SITARZ

BECKER

GAFFORD


KOPE

Hans W. Sitarz: Joined Thiokol Chemical Corp.'s Southeast District Office, Huntsville, Ala., as manager-Army programs.

Dr. Herbert D. Becker: Appointed director of engineering sciences at Allied Research Associates, Inc., Concord, Mass.

Vernon D. Varenhorst: Appointed director of marketing for Huggins Laboratories, Inc., Sunnyvale, Calif. **Dr. Richard J. Burke** appointed manager of the systems division.

A. E. Abramson: Appointed president of the newly formed Controls Div. at Research, Inc., Minneapolis. **James R. Anderson** named vice president and **John M. Law** named sales manager. **Herbert C. Johnson** appointed president and general manager of the newly formed MTS Div. **George N. Butzow** named assistant general manager and sales manager.

George L. Loomis: Named vice president of operations for Lear-Siegler, Inc.'s Power Equipment Div., Cleveland.

Dr. Robert D. Gafford: Joined Beckman Instruments, Inc.'s Space Engineering Dept., Fullerton, Calif., as manager-life sciences.

Raymond Capiaux: Named senior member, fluid mechanics of Lockheed Missiles & Space Co.'s mechanical and mathematical sciences laboratory, Palo Alto, Calif.

John J. Kope, Jr.: Appointed vice president-marketing at California Instruments Corp., San Diego.

Dr. Kaj L. Nielsen: Joined the enginering staff of Battelle Memorial Institute, Columbus, Ohio, as director of systems analysis.

Walter J. Schafer: Named program director for re-entry systems in the new Space Systems Div. of Fairchild Stratos Corp., Washington, D.C.

Leonard B. Wagner: Named manager of engineering in General Electric Co.'s Semiconductor Products Dept., Syracuse, N.Y.

Charles M. Mooney: Appointed division vice president, Federal Government Systems Support, Radio Corp. of America, Washington, D.C.

Victor V. Blasutta: Appointed vice president and general manager of the Denison Engineering Div. of American Brake Shoe Co., Columbus, Ohio.

Russell L. Henry: Appointed manager of contract administration for the Space-General Corp., El Monte, Calif.

Joseph Mahler: Appointed senior staff engineer at Motorola's Chicago Military Electronics Center.

Frank C. Buhlman: Named treasurer of Telecomputing Corp., Los Angeles.

John E. Wiseman: Appointed director of sales and marketing at James Cunningham, Son & Co., Honeoye Falls, N.Y.

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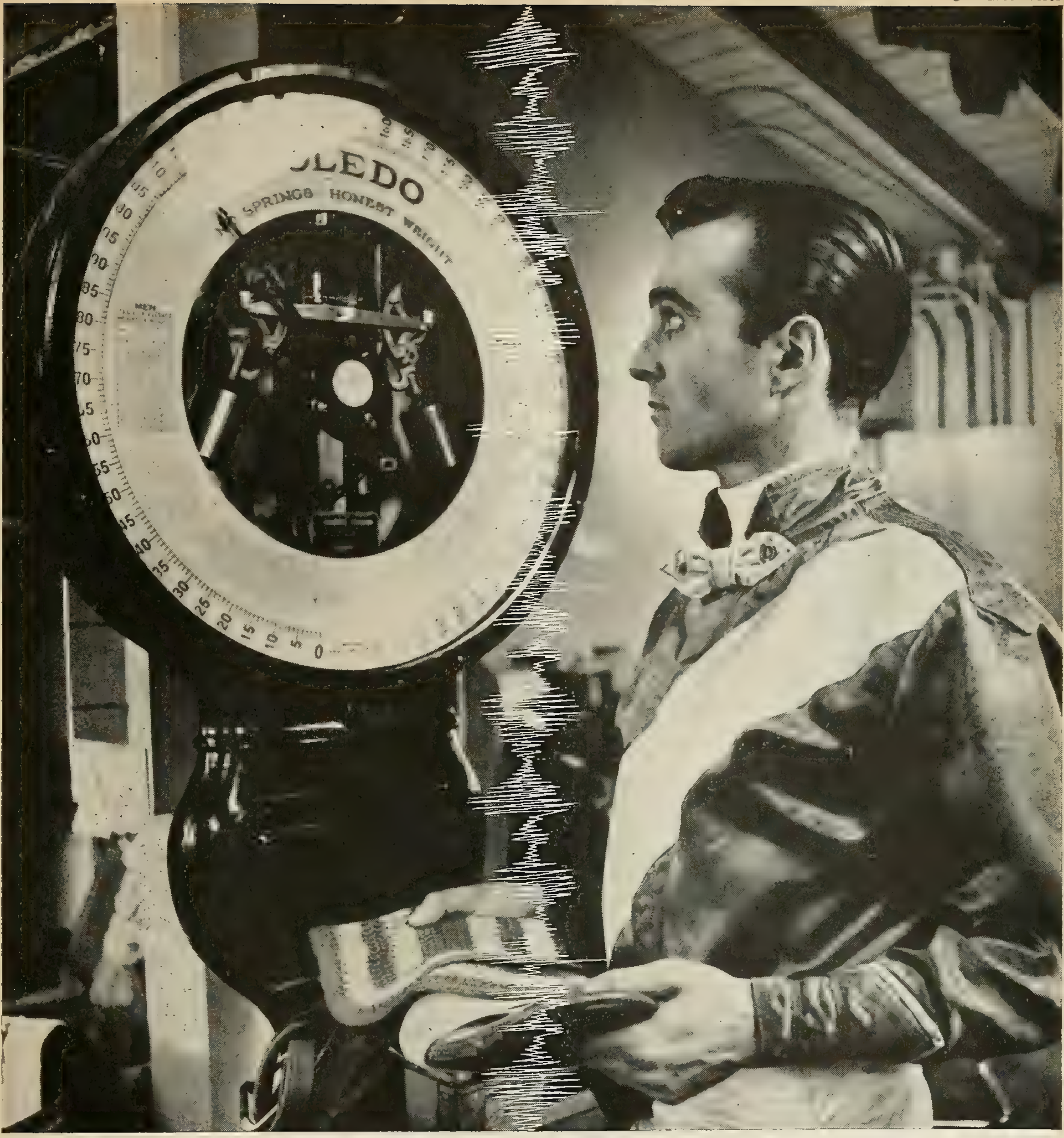

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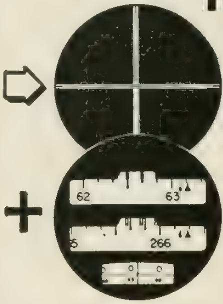

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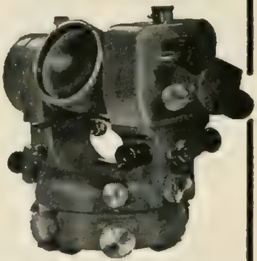

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AIAA Conference on Physics of Entry into Planetary Atmospheres, Massachusetts Institute of Technology, Cambridge, Aug. 26-28.

AIEE Pacific General Meeting, Davenport Hotel, Spokane, Wash., Aug. 26-29.

AIME Electronic Material Conference Somerset Hotel, Boston, Aug. 26-28.

18th Annual Conference of the Association for Computing Machinery, hosted by the University of Denver, Denver Hilton Hotel, Denver, Aug. 27-30.

SEPTEMBER

Open Space and Peace Symposium, sponsored by the Hoover Institution on War, Revolution and Peace and by Stanford University, Stanford, Calif., Sept. 4-6.

Symposium on the Ellipsometer and Its Use in the Measurement of Surfaces and Thin Films, National Bureau of Standards, Washington, D.C. Sept. 5-6.

International Symposium on High Temperature Technology, sponsored by Stanford Research Institute, Asilomar, Calif., Sept. 8-11.

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

National Symposium on Space Rendezvous, Rescue and Recovery, sponsored by American Astronautical Society and Air Force Flight Test Center, Edwards Air Force Base, Calif., Sept. 10-12.

17th Annual National Convention and Aerospace Panorama, Air Force Association, Sheraton-Park and Shoreham Hotels, Washington, D.C., Sept. 11-15.

American University, Institute of Electronic Informations Display Systems, International Inn, Washington, D.C., Sept. 16-20.

Industrial Electronics Conference, sponsored by AIEE, IRE and ISA, Michigan State University, East Lansing, Sept. 18-19.

IEEE Annual Conference on Communications, Cedar Rapids Section, Hotel Roosevelt, Cedar Rapids, Iowa, Sept. 20-21.

National Power Conference, sponsored by ASME, AIEE and IRE, Netherland-Hilton Hotel, Cincinnati, Sept. 22-25.

International Telemetering Conference, Hilton Hotel, London, Sept. 23-27.

Aeroelastic and Dynamic Modeling Technology Symposium, sponsored by Air Force Systems Command's Aeronautical Systems Div. and the AIA, Biltmore-Hilton Hotel, Dayton, Ohio, Sept. 23-25.

Recently Acquired Knowledge of the Space Environment Meeting, sponsored by the XIVth International Astronautical Congress and the International Astronautical Federation with the cooperation of UNESCO and COSPAR, UNESCO House, Paris, Sept. 27.

IRE Canadian Electronics Conference, Toronto, Can., Sept. 30-Oct. 2.

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Supermarket for Space

THE PROPOSAL by Representative Joseph Karth that the U.S. undertake an active effort to sell its space boosters to other nations (see p. 21) is a welcome one to American industry.

It should be equally welcome in other nations.

As the Minnesota Democrat, a veteran member of the House Space Committee, is well aware, there are a number of obstacles to be overcome in any such program. But they do not appear insurmountable.

Security stands out as the major problem. But this can be met by retaining launch control in American hands. Any nation interested in such a purchase would, in effect, buy not a launch vehicle but a launch.

This would be necessary in any event since other nations, with the exception of the Soviet Union, do not possess the capability of launching large space boosters. The capital investment in a launch complex, with its myriad of test and checkout equipment, computers, tracking radars and other electronic gear, is not an attractive proposition for smaller nations of the world.

Nor is the investment in the industrial capability to build large space boosters. The U.S. already has made both these investments and is in a position to "rent" these capabilities to other countries.

What is required is a national policy decision that this is indeed a desirable thing to do.

A partial step in this direction has been taken with the National Aeronautics and Space Administration international programs. *Scout* and *Thor* vehicles are being used to boost payloads for other nations. Britain's *Ariel* and Canada's *Alouette* were boosted into orbit by U.S. launch vehicles.

These boosters were not sold, however. This nation is willing to provide free launch vehicles for those experiments or satellites which it regards as of mutual scientific interest.

NASA's director of international programs, Arnold Frutkin, reports that U.S. policy also permits outright sale of *Scouts* and *Thors* to foreign nations.

There is as yet no policy which would permit the outright sale of an *Atlas* or *Titan* to a foreign nation. Nor does it appear that any such policy is likely to be in the national interest in the near future.

But there could be a declared willingness to sell the launch of an *Atlas* or *Titan,* with or without *Agena* or *Centaur* upper stages. There is precedent for this in the sale to American Telephone and Telegraph Co. of the *Thor-Delta* launch vehicles and NASA services for *Telstar.*

What would the nations of Europe or elsewhere have to gain from such a purchase? Primarily, it would enable them to step into the Space Age without the prohibitive cost of developing their own booster technology and production capability.

Smaller nations could concentrate on developing satellite technology with the assurance that boosters would be available to them. They would be free to pursue their own scientific or commercial objectives in space—without having to prove a mutual interest.

WOULD NATIONAL PRIDE permit such a dependence on U.S. technology? Probably—with the possible exception of Gen. de Gaulle. Many a foreign dignitary rides in a Cadillac or Rolls-Royce without undue worry over the fact that his nation lacks an automobile industry.

Would the U.S. Congress stand still for such a sale of this nation's capabilities, which might be used in competitive programs? Would the prospect of the launch of a foreign communications satellite, for example, be sufficient to discourage any efforts in this direction? Possibly, but again there is ample precedent for sale of U.S. equipment to foreign industries directly competitive with our own.

There would, of course, have to be some restriction on the uses to which such boosters might be put. Rep. Karth has pointed out, however, that a predetermined set of standards could be established for this.

"Certainly, we wouldn't make available to a foreign country a booster to launch an atomic bomb just to further develop that country's technology in the development of nuclear energy," he points out.

Problems in this area would not be too difficult to work out.

The big question that remains is whether other nations would really put the money on the line for such expensive launches. There has been no market for outright purchase of the *Thors* or *Scouts* already available.

We believe, however, there might be a strong interest in the continuing availability of big boosters around which a nation could design substantial space projects. Sizable space budgets might appear where none now exist.

The only way to find out is to establish such an open-door policy for our big launch vehicles and upper stages, let U.S. sales representatives abroad do a little aggressive promoting—and see what happens.

William J. Coughlin

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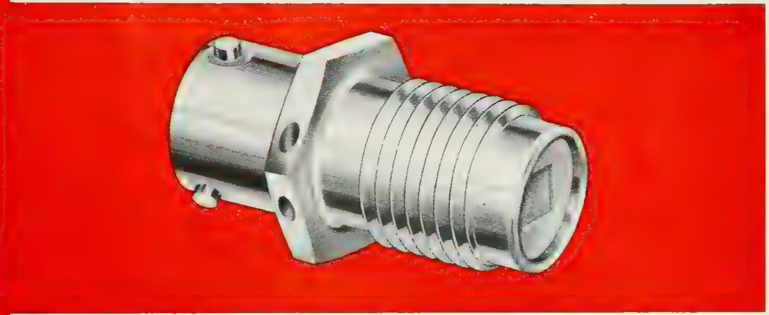

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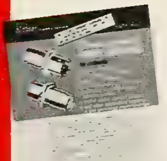

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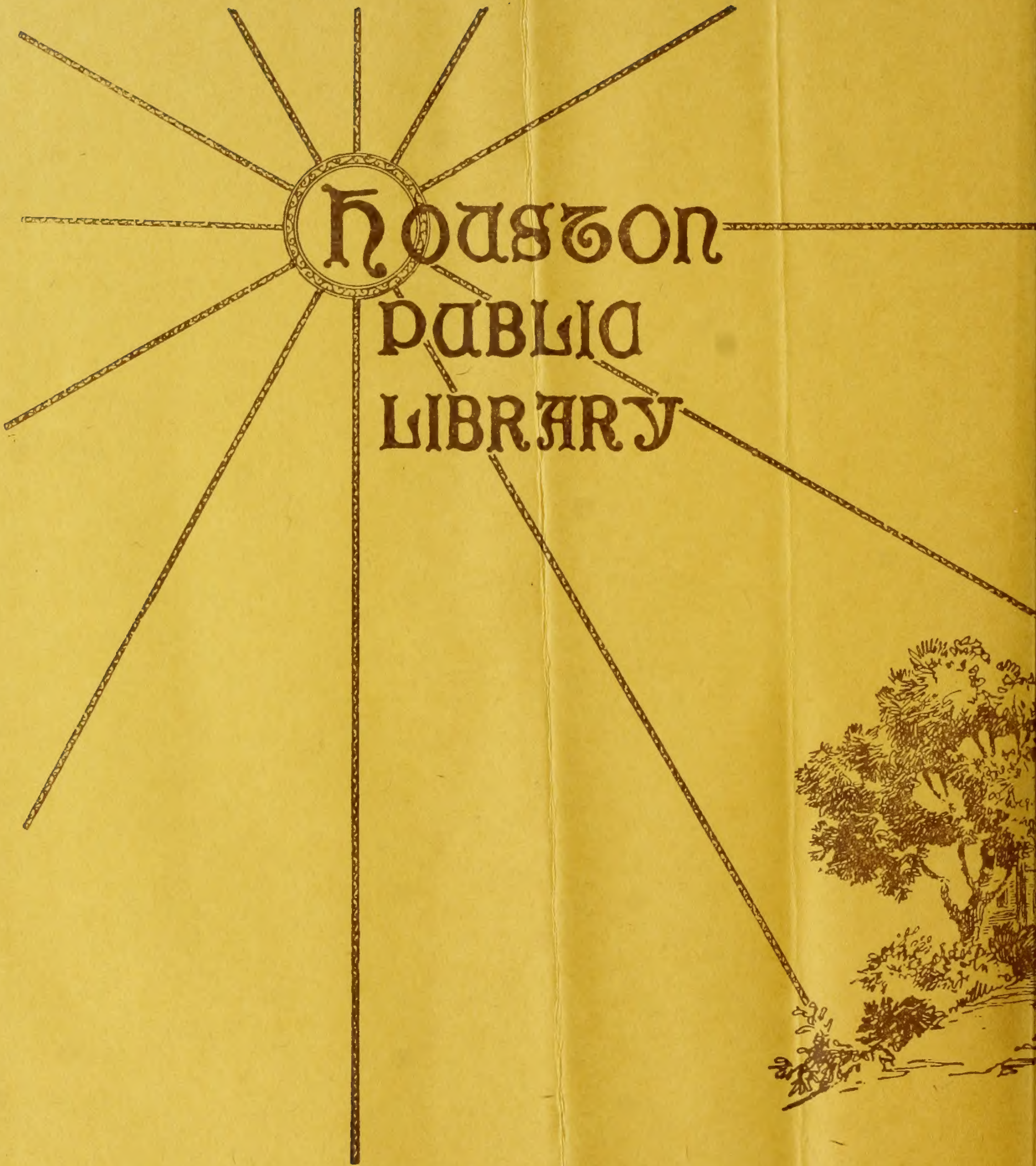

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